Building health informatics skills for health professionals: results from the Australian Health Informatics Skill Needs Survey

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Abstract

Objective: To ascertain health professionals' perceptions of health informatics skills required in their roles.

Design: A paper-based survey with a stratified random sample of Australian health professionals and a web-based survey open to all Australian health professionals were conducted.

Measurement: A questionnaire on the health professionals' perceived degree of competency required for a total of 69 specific skills in five skill categories based on the International Medical Informatics Association's (IMIA) set of recommendations on education and IMIA's scientific map.

Results: 462 health professionals responded to the paper-based questionnaire, and 167 respondents to the Internet questionnaire. Internet respondents reported higher required degrees of competency for specific health informatics and information technology skills than paper respondents, while paper respondents valued clinical skills higher than the Internet respondents.

Conclusion: Health professionals increasingly use information technology (IT), and some also deploy, research or develop health care IT. Consequently, they need to be adequately educated for their specific roles in health informatics. Our results inform developers of educational programs while acknowledging the diversity of roles in health informatics and the diversity of pathways towards a professional health informatics qualification.

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What is known about the topic?

Health professionals need to be adequately educated in health informatics. There are various roles and various interests in health care which require different health informatics skills.

What does this paper add?

This paper discusses the health informatics skills perceived by health professionals to be required for them to function in their roles. There were significant differences between the Internet-based and paper-based survey respondents, with the Internet-based responses focusing on management skills (such as project management and risk management) and the paper-based respondents identifying clinical skill issues. Of note, "expressing complex clinical knowledge in plain English" was identified as a high need skill by both sets of respondents.

What are the implications for practitioners?

Based on this analysis, educational programs can be designed or updated to meet the education and training needs of health professionals in enhancing the skills relevant to their specific role in health informatics. Practitioners need to be aware of the need for health informatics education and its potential. ◆

INTERNATIONALLY, HEALTH INFORMATICS education has matured with myriad different ways for health informatics professionals to be educated. For example, as one of the first, the University of Heidelberg and the University of Applied Sciences, Heilbronn, in Germany established a jointly run medical informatics program in 1972.[1] The International Medical Informatics Association (IMIA) boasts nearly 50 academic institutional members (http://www.imia.org/inst_members.html) and the American Medical Informatics Association (AMIA) has identified around 70 health informatics education providers in the USA alone (http://www.amia.org/informatics/acad&training/index.asp).

It is crucial for health professionals to possess at least basic informatics skills, as health professionals including medical practitioners, nurses and allied health professionals, increasingly use information technology (IT).[2] Some also deploy, research or develop health care IT. Consequently, they need to be adequately educated for their specific roles in health informatics. In recognition of this, the recently launched "10x10" program (http://www.amia.org/10x10) of the American Medical Informatics Association (AMIA) aims to train 10000 health care professionals in applied health informatics by the year 2010 in a wide range of settings across the United States. Since 2002, Germany has required health informatics competencies as a precondition for licensing physicians. The incorporation of the required health informatics education was discussed in a recent paper published by the German Society for Medical Informatics, Biometry and Epidemiology (GMDS).[3]

The development of an Australian or international *Educational framework for health informatics professionals*[4] could also assist with program accreditation, positioning the results of any recognition of prior learning exercise, and the administration of credit transfers, and could provide clarity about the relative position of different qualifications.[5] To remain relevant and current in the content and delivery of health informatics education and training and to ascertain health professionals' perceptions of HI educational needs and priorities, we developed a questionnaire to survey health professionals on the preferred knowledge and skills set for their role in health informatics.

The aim of this paper is to:

- present and discuss results of the Australian Health Informatics Professionals Skill Needs Survey; and
- present and discuss statistically significant differences between various (demographic) groups.

Background

As a step towards international health informatics education, IMIA's endorsed set of recommendations on education in health and medical informatics was published in 1999.[6] The recommendations include topic areas to be covered within each of three knowledge/skill domains and the level of knowledge required in terms of "introductory", "intermediate" or "advanced". The IMIA recommendations recognise that students undertaking health informatics education are either undertaking an undergraduate degree in one of the health professions or in informatics (eg, computer science, information and communication technology, information management, information science, bioinformatics) or they have previously graduated with a degree in a wide variety of knowledge domains. IMIA's scientific map (http://www.imia.org/endorsed.html) also provides guidance regarding the necessary skills in health informatics, and the Health and Medical Informatics Education Working Group (WG 1; http://www.imia.org/wg1/) aims to disseminate and exchange information on health informatics programs and courses.

In the USA, a survey of academic and industry professionals was conducted by Hoffmann and Ash[7] to foster an understanding of the preferred skill set of graduates of medical informatics programs. Recent research by others also analysed the various roles and functions of health informatics professionals and associated competencies,[8-11] and a major workforce research study regarding skill sets for health information management has been conducted.[12] These studies usually employed a "roles-based" approach to identify required competencies for each role.

Methods

The survey questionnaire

The questionnaire used for this study was a slightly modified version of a questionnaire initially developed by the authors to ascertain the skill needs for nurses in their role as health informatics professionals. The complete rationale is discussed in detail elsewhere.[13] In summary, the development was based on an extensive literature review and the IMIA-endorsed documents.

The questionnaire was divided into two parts: demographic questions and knowledge/skills questions. The knowledge/skills questions were further divided into five categories to reflect the highly interdisciplinary field of health informatics. These were:

- specific health informatics knowledge/skills;
- information technology knowledge/skills;
- people and organisational knowledge/skills;
- clinical and related knowledge/skills; and
- various knowledge/skills.

The internationally recognised degrees of competencies as introduced by Benner[14] ("novice", "advanced beginner", "competent", "proficient", and "expert") were employed in this survey and given values from 1 (novice) to 5 (expert). As we expected that not all health professionals are sufficiently confident with health informatics terminology we gave — in addition to Benner's five levels of competencies — the possibility to answer "don't know". Further, to indicate that a knowledge/skill is not applicable, we gave the option of "not applicable". Similar to the Canadian "Competencies and curricula in health informatics" report[11] we defined three primary roles persons can take on in health informatics: They can:

- primarily *use* IT in health care;
- primarily *deploy* IT in health care; or
- primarily *research and/or develop* IT in health care.

Form and distribution of the survey

A web-based version of the questionnaire was developed to address the more IT literate part of Australia's health workforce. We set up the survey using QuestionPro.com technology and widely circulated the web-based questionnaire across the membership of Australia's professional health associations and colleges. We also sent a reminder after 3 weeks. We could not exclusively rely on Internet-based survey techniques, as we anticipated biased results if only people with Internet access and the appropriate information technology literacy (and interest) could respond to the survey. Therefore, a paper-based questionnaire was developed to address a representative sample of Australia's health workforce. We sent the questionnaire together with a covering letter and return envelope to a stratified random sample of 3000 Australian health professionals consisting of the following nine strata: practising doctors (various classifications); radiologists; dentists; nurses; pharmacists; physiotherapists; podiatrists; dietitians; and complementary medicine professionals. To increase the response rate, an additional letter and a copy of the questionnaire was sent after 4 weeks to remind the non-responders. Returns were electronically processed using Cardiff Software TELEform automated document and data capture applications. The questions asked in both survey distributions were identical to allow comparison of the results; also no advanced features of web-based surveys were used. The study was conducted in December 2004 and January 2005.

Results

Demographics

Altogether, 629 health professionals completed the questionnaire, 167 via the Internet and 462 using the paper-based questionnaire. Of the valid responses received from health professionals, 51.4% were female, compared with 74% of the overall Australian health professional workforce. Of the responding health professionals, 3.4% were younger than 30 years; 18% were 30–39 years; 37.6%, 40–49 years; 30.1%, 50–59 years; and 11%, 60 years and over. This resulted in an approximate average age for the respondents of 47 years compared with the average age for Australian health professionals of about 43 years (estimated based on Australian Institute of Health and Welfare: Australia's Health report[15]).

Of the respondents, 86.1% described their primary role in health informatics as "I use information technology in health care"; 8.5% described their primary role as "I deploy information technology in health care"; while the remaining 5.4% described their primary health informatics role as "I research and develop information technology in health care". Asked for their degree of competency in their primary health informatics role, 17% answered "novice"; 25.4%,

1 Overview of the top 23 skills for the Internet-based and the paper-based survey

Internet-based survey				Paper-based survey		
Mean	Category	Skill	Rank	Skill	Category	Mean
3.76	PO	Expressing complex clinical knowledge in plain English	1	Anatomy	CL	3.49
3.69	PO	Effective communication between health and IT professionals	2	Physiology	CL	3.43
3.61	PO	Social competency	3	Expressing complex clinical knowledge in plain English	PO	3.35
3.43	HI	Health data, information and knowledge management	4	Pathology	CL	3.32
3.38	CL	Evidence-based practice	5	Diagnostic and therapeutic strategies	CL	3.27
3.38	PO	Change management	6	Clinical guidelines	CL	3.26
3.37	HI	Electronic patient records/ electronic health records	7	Evidence-based practice	CL	3.21
3.35	CL	Clinical guidelines	8	Ethics	VAR	3.08
3.33	PO	Quality and safety management	9	Clinical disciplines (internal medicine, surgery, etc.)	CL	3.08
3.29	PO	Project management	10	Social competency	PO	3.05
3.28	HI	Health care organisation and administration	11	Biochemistry	CL	3.01
3.26	PO	Risk management	12	Effective communication between health and IT professionals	PO	2.96
3.24	VAR	Ethics	13	Electronic patient records/ electronic health records	HI	2.92
3.19	HI	Management of health information systems	14	Clinical trials	CL	2.88
3.17	HI	Outcome measurement/ practice evaluation	15	Health data, information and knowledge management	HI	2.85
3.14	HI	Health information systems (general characteristics, architecture)	16	Risk management	PO	2.84
3.09	CL	Physiology	17	Quality and safety management	PO	2.82
3.08	HI	Health concept representation	18	Health information systems (general characteristics, architecture)	HI	2.73
3.08	CL	Clinical disciplines (internal medicine, surgery, etc.)	19	Business management	VAR	2.71
3.08	CL	Anatomy	20	Health care organisation and administration	HI	2.70
3.04	CL	Diagnostic and therapeutic strategies	21	Health concept representation	HI	2.69
3.01	VAR	Business management	22	Management of health information systems	HI	2.61
2.98	IT	Business analysis/ workflow analysis	23	Project management	PO	2.60

The skills are categorised as: HI = specific health informatics skills; IT = information technology skills; PO = people and organisational skills; CL = clinical and related skills; VAR = various skills. ◆

"advanced beginner"; 33.7%, "competent"; and 17%, "proficient"; 6.9% considered themselves expert in their primary health informatics role.

Asked for the statement that best describes their primary interest in health informatics, 36.5% answered "I want to use information effectively"; 49.1% answered "I want to use information technology effectively"; while the remaining 14.5% answered "I want to manage information technology projects effectively".

2 Overview of the middle 23 skills for the internet-based and the paper-based survey.

Internet-based survey				Paper-based survey		
Mean	Category	Skill	Rank	Skill	Category	Mean
2.97	IT	Systems analysis/ user requirements identification	24	Outcome measurement/practice evaluation	HI	2.60
2.92	CL	Pathology	25	Change management	PO	–
2.87	VAR	Legal understanding	26	Legal understanding	VAR	2.57
2.85	HI	Decision support systems/ knowledge based systems/expert systems	27	Statistics	VAR	2.55
2.84	CL	Clinical trials	28	Organ imaging informatics	HI	2.50
2.84	VAR	Social science	29	Social science	VAR	2.47
2.83	CL	Biochemistry	30	E-Health/telehealth/telemedicine	HI	2.47
2.81	IT	Database querying	31	Database management	IT	2.33
2.74	IT	Database management	32	Decision support systems/ knowledge based systems/expert systems	HI	2.32
2.73	UT	Systems design/technical requirements specification	33	Mathematics	VAR	2.31
2.73	HI	E-health/telehealth/telemedicine	34	Epidemiology	HI	2.30
2.70	IT	Systems test	35	Economics	VAR	2.29
2.67	HI	Health informatics standards (HL7 etc.)	36	Medical physics	VAR	2.29
2.65	VAR	Statistics	37	Operating systems and administration	IT	2.17
2.60	IT	User interface design	38	Coding and classification (ICD, DRG etc.)	HI	2.15
2.57	VAR	Economics	39	Database protection and security	IT	2.13
2.54	IT	Database design	40	Business analysis/workflow analysis	IT	2.12
2.52	IT	Database protection and security	41	Database querying	IT	2.08
2.51	IT	Software development methodologies and processes	42	Health informatics standards (HL7 etc.)	HI	2.07
2.51	HI	Coding and classification (ICD, DRG etc.)	43	Systems analysis/user requirements identification	IT	2.03
2.50	IT	Operating systems and administration	44	Bioinformatics	HI	2.02
2.46	VAR	Mathematics	45	Genomics	CL	2.01
2.43	IT	Graphical data processing	46	Network and other protocols	IT	1.99

Overview of results

Box 1, Box 2 and Box 3 provide an overview of the survey results for the skills that are seen by survey respondents to be requiring high, medium and low degrees of competencies. The mean values for the respective skills are shown. We differentiated between the results of the paper-based and web-based survey. For more detailed results for the respective skills refer to the full report available at <http://healthinformatics.cqu.edu.au/projects/hisurvey>.

As a summary question, we asked the health professionals to assess the overall degree of competency required for each of the five skill categories. Box 4 provides an overview of the mean values for the overall degree of competency required to create the ideal health informatics skills package as perceived by respondents.

3 Overview of the bottom 23 skills for the Internet-based and the paper-based survey

Internet-based survey				Paper-based survey		
Mean	Category	Skill	Rank	Skill	Category	Mean
2.43	HI	Epidemiology	47	Database design	IT	1.98
2.39	IT	Technical informatics	48	Biometry	HI	1.95
2.39	IT	Modelling (objects, processes; UML)	49	Graphical data processing	IT	1.94
2.36	IT	Programming principles	50	Real time data processing	IT	1.89
2.31	IT	Algorithms and data structures	51	Systems design/technical requirements spec	IT	1.89
2.30	IT	Programming languages	52	Programming principles	IT	1.85
2.30	IT	Theoretical informatics	53	Speech recognition	IT	1.84
2.28	IT	Network and other protocols	54	Systems test	IT	1.83
2.24	IT	Real time data processing	55	Artificial intelligence in medicine	HI	1.82
2.06	CL	Genomics	56	User interface design	IT	1.77
2.06	IT	Distributed systems	57	Medical signal processing	HI	1.77
2.05	HI	Organ imaging informatics	58	Software development methodologies and processes	IT	1.74
2.01	VAR	Medical physics	59	Programming languages	IT	1.70
2.00	IT	System programming	60	Mathematical models in medicine/biomedical modelling	HI	1.66
1.96	HI	Bioinformatics	61	System programming	IT	1.65
1.92	HI	Biometry	62	Technical informatics	IT	1.64
1.77	HI	Artificial intelligence in medicine	63	Technology of measurement and electrical engineering	HI	1.64
1.75	IT	Speech recognition	64	Theoretical informatics	IT	1.63
1.71	VAR	Cryptology/cryptography	65	Modelling (objects, processes; UML)	IT	1.63
1.71	HI	Medical signal processing	66	Algorithms and data structures	IT	1.62
1.51	HI	Mathematical models in medicine/ biomedical modelling	67	Distributed systems	IT	1.60
1.47	HI	Technology of measurement and electrical engineering	68	Cryptology/ cryptography	VAR	1.54
1.39	HI	Medical robotics	69	Medical robotics	HI	1.49

4 Respondent means for the overall degree of competency to create the ideal health informatics skills package

Internet-based survey			Paper-based survey	
Mean	Skill	Rank	Skill	Mean
3.84	People and organisational knowledge/skills	1	Clinical and related knowledge/skills	3.67
3.59	Clinical and related knowledge/skills	2	People and organisational knowledge/skills	3.38
3.43	Specific health informatics knowledge/skills	3	Various knowledge/skills	3.18
3.33	Information technology knowledge/skills	4	Specific health informatics knowledge/skills	3.11
3.29	Various knowledge/skills	5	Information technology knowledge/skills	2.96

1 = novice; 5 = expert. ◆

Consistent with our original expectations, there were statistically significant differences between the respondent profiles and perceptions from the paper-based and web-based surveys. Several significant differences were found when analysing each skill category with regard to selected demographics or when comparing Internet and paper-based survey responses (Box 5). Gender differences were minimal, with significant differences only for clinical and related skills (with ratings from males higher). No significant age differences could be found except for significant differences for IT skills (with ratings from people aged 29 and below higher than those of people aged 60 and above). There are significant differences for all categories except specific health informatics skills for the various professions (Box 6A). Significant differences could be found for the respondent's experience in their primary role in health informatics (the higher the respondent's experience, the higher her/his assessment of the degree of competency needed) (Box 6B). Similar significant differences for all categories except clinical and related skills were found for the respondent's primary role in health informatics. These are detailed in Box 6C.

It seems that the Internet respondents were more inclined to rate specific health informatics skills and information technology skills higher than paper respondents, whereas paper respondents valued clinical and related skills higher than the Internet respondents (Box 6D). Given the expectation that not all health professionals are sufficiently confident with health informatics terminology, we analysed the skills with the highest and lowest number of respondents answering "don't know" and "not applicable" (Box 7). This gives some indication of the issues of which health professionals may not be aware.

Discussion

We asked for the degree of competency required for roles in health informatics. This does not directly imply anything about the degree of competency health professionals *possess,* and there-

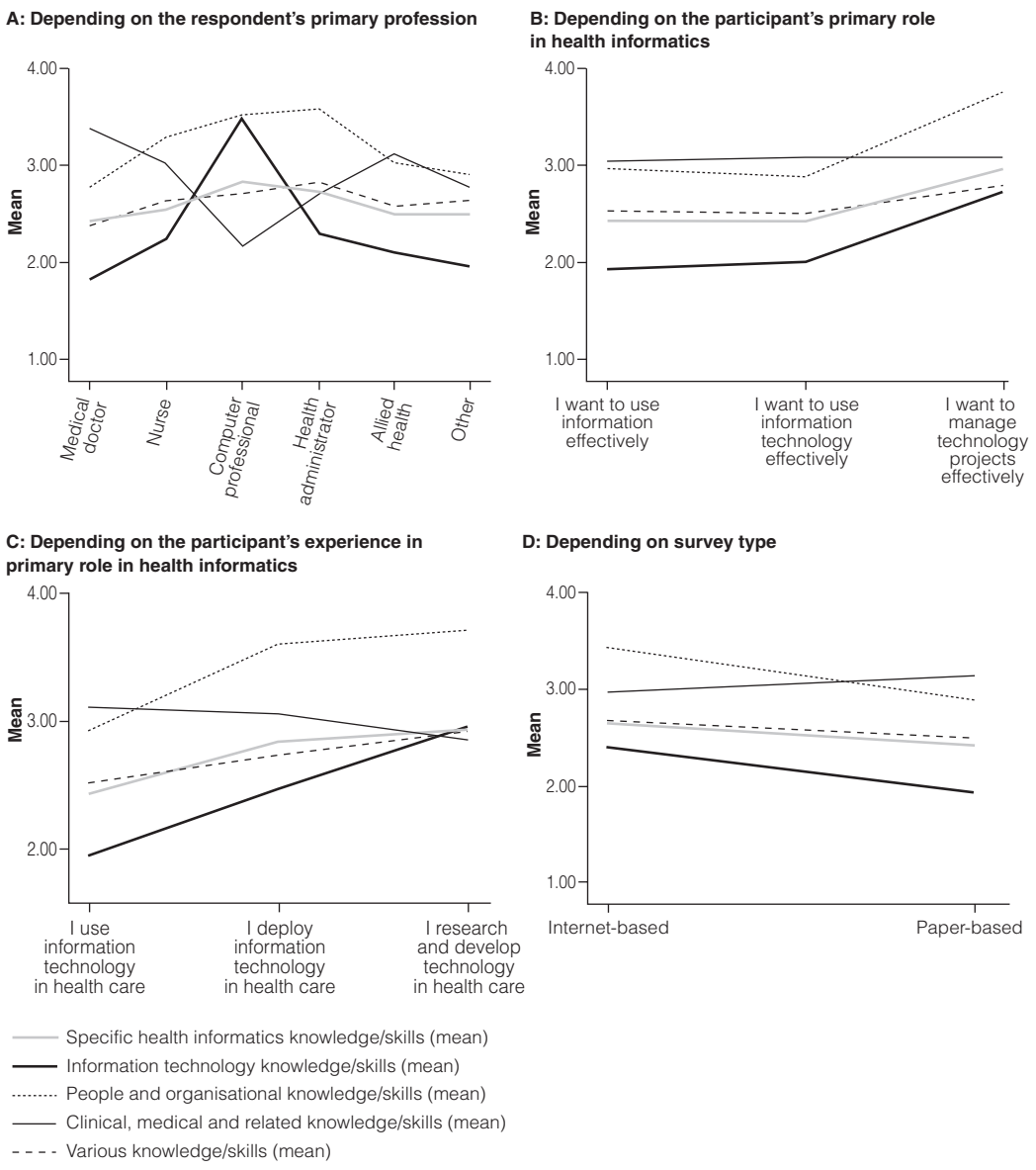
5 Summary of significant differences at a 0.05 significance level

	HI	IT	PO	CL	VAR
Gender	–	–	–	0.022	–
Age	–	0.010	–	–	–
Profession	–	<0.001	<0.001	<0.001	0.012
HI role	<0.001	<0.001	<0.001	–	0.009
Experience in HI role	<0.001	<0.001	<0.001	–	<0.001
Interest in HI	<0.001	<0.001	<0.001	–	0.035
Internet/ paper-based	0.002	<0.001	<0.001	(0.065)	0.017

HI = specific health informatics knowledge/skills; IT = information technology knowledge/skills; PO = people and organisational knowledge/skills; CL = clinical and related knowledge/skills VAR = various knowledge/skills. ◆

fore, strictly speaking, it could be that health professionals currently are even more competent than required for some roles. Some of the participant's comments (listed in the full report at <http://healthinformatics.cqu.edu.au/projects/hisurvey>) as well as the relatively low response rate for the paper-based questionnaire, indicate that there still is a lack of understanding of what health informatics is and that a lack of general IT literacy prevails as a major problem. Further, the relatively high number of respondents answering "don't know" or "not relevant" suggests that there

6 Mean values for the overall degree of competency required to create the ideal health informatics skills package as perceived by respondents



is not sufficient understanding of key issues or their significance. The results of this survey indicate that many Australian health professionals don't know what they need to know with regard to health informatics, let alone have the required core competencies to efficiently work in a computerised health environment. Initiatives like the American 10x10 program for educating health professionals in applied health informatics, or the introduction of mandatory informatics education as a precondition for licensing medical practitioners as is required in Germany, may be required for efficient health care in Australia.

While computation of a median or mode is easily justified for such ordinal data, some statisticians have reservations about computing a mean for ordinal data. Others argue that a mean score of 2.5 in comparison to a mean score of 2.9 is more meaningful than a median of 3 for both and that for this reason it makes sense to accept minor statistical inaccuracies for the sake of added meaning. (For a more comprehensive discussion of this issue, see for example Jacobsson's analysis[16] or <http://www.psychstat.missouristate.edu/introbook/sbk06m.htm>).

The survey results help to confirm the core competencies needed to inform education and professional development in health informatics. They may enable professional colleges, health service providers, health informatics education providers and health informatics organisations to develop and provide education and ongoing training for health professionals. The focus of this research has been on the perceptions of individual health professionals as they relate to their own roles in health informatics. This approach is necessary as one piece of a thorough foundation for a health informatics educational framework. It is possible — and at least partly demonstrated by our study (Box 5, Box 6) — that the perceptions of, for example, administrators, project managers and technical specialists working with health professionals differ significantly from the perceptions of health professionals themselves. There is reason to believe that respondents are more technically savvy than non-respondents. While this is certainly a limitation of this study, we believe that the results are even more informative towards our research questions than without this potential bias, as we received answers from people who are more knowledgeable in this area.

Different forms and levels of health informatics education are relevant to a wide range of professional participants, and health professionals must be adequately educated for their specific role in health informatics. For example, senior managers of health services, clinical and IT staff will have different roles to fulfil in health informatics including: the use of information technology, deployment of information technology, and in research and development of information technology in health care (Box 6C). People and organisational skills such as project and change management, quality, safety and risk management, social competency, effective communication between health and IT professionals, and expressing complex clinical knowledge in plain English are regarded as requiring a high degree of competency. Although traditionally not regarded as a technical or clinical skill, "expressing complex clinical knowledge in plain English" was the skill with the highest score in the paper-based survey. Further, it is evident that at least a solid foundation of clinical and related knowledge/skills is required for health informatics roles. Throughout the survey, skills/knowledge with regard to electronic patient records/electronic health records and health data, information and knowledge management are regarded as extremely valuable specific health informatics skills, while it is somehow surprising that cryptology/cryptography scored so low, as it is the undeniable basis for secure systems in health care. Medical signal processing and artificial intelligence in medicine also scored low mean values. This may be due to the fact that current examples in clinical practice may still be limited and therefore not known by the health professionals. This may also be indicated by the high numbers of respondents answering "don't know" especially for cryptology/cryptography and medical signal processing (Box 7).

Differences between the results of the paper-based and the Internet-based survey as well as differences between the responses of the various

7 The top and bottom 15 skills with response of "not applicable" and "don't know"

"Not applicable"		"Don't know"	
Skill	**No. of respondents**	**No. of respondents**	**Skill**
Top 15			
Medical robotics	168	138	Distributed systems
System programming	164	129	Medical signal processing
Mathematical models in medicine/ biomedical modelling	159	129	Biometry
Modelling (objects, processes; UML)	155	122	Cryptology/cryptography
Distributed systems	154	122	Bioinformatics
Technology of measurement and electrical engineering	153	114	Medical robotics
Speech recognition	146	114	Technology of measurement and electrical engineering
User interface design	146	113	System programming
Systems test	145	111	Mathematical models in medicine/ biomedical modelling
Theoretical informatics	145	109	Speech recognition
Medical signal processing	140	108	Modelling (objects, processes; UML)
Systems design/technical requirements specification	139	108	Graphical data processing
Artificial intelligence in medicine	137	104	User interface design
Algorithms and data structures	137	104	Technical informatics
Software development methodologies and processes	137	103	Systems design/technical requirements specification
Bottom 15			
Outcome measurement/practice evaluation	38	30	Evidence-based practice
Expressing complex clinical knowledge in plain English	37	29	Effective communication between health and IT professionals
Statistics	36	29	Anatomy
Risk management	35	29	Clinical guidelines
Biochemistry	35	29	Health information systems (general characteristics, architecture)
Pathology	34	28	Management of health information systems
Effective communication between health and IT professionals	33	26	Statistics
Anatomy	30	26	Ethics
Clinical guidelines	30	25	Legal understanding
Physiology	29	23	Biochemistry
Ethics	28	22	Expressing complex clinical knowledge in plain English
Legal understanding	28	20	Electronic patient records/electronic health records
Health information systems (general characteristics, architecture)	24	20	Pathology
Evidence-based practice	23	20	Health data, information and knowledge management
Health data, information and knowledge management	23	19	Physiology

health professions suggest that clinicians' frame of reference is focused more on remembering (for example knowledge in anatomy and physiology) than appropriate access to knowledge and information. For example, it appears that conventional IT skills are not regarded as very important. However, this is mainly true for health informatics professionals whose primary role is to use information technology in health care as opposed to health informatics professionals with a primary role to deploy, research or develop information technology in health care, for which significant differences occurred ($P < 0.001$, Box 5). This is in harmony with the IMIA recommendations on education in health and medical informatics[6] and supports the theory that health professionals need various degrees of competencies for IT skills depending on their role in health informatics.

The analysis of the various differences related to respondent's characteristics let us assume that age is only a minor factor among many. We therefore believe that it is not safe to simply wait until the older generation retires and younger and potentially more computer-literate health professionals are trained: pro-active management of health informatics education for health professionals seems essential.

Conclusion

Pro-active development and management of health informatics education for health professionals is essential for high quality and efficient patient care[2, 17] and can help in closing the loop between clinical practice, research and education.[18] Initiatives may have to be put in place to develop the necessary health informatics competence for health professionals in Australia. Depending on the individual's role and expertise, skills from basic computer competencies to people and organisational skills, advanced information technology skills and special health informatics skills need to be developed. Our results support universities and other education providers in the development, delivery and promotion of flexible and relevant health informatics education tailored to the individual health professional's need.

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Competing interests

The authors declare that they have no competing interests.

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