Forecasting Informatics Competencies for Nurses in the Future of Connected Health
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IMIA Educational Recommendations and Nursing Informatics

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Abstract. The updated version of the IMIA educational recommendations has given an adequate guidelines platform for developing educational programs in Biomedical and Health Informatics at all levels of education, vocational training, and distance learning. This chapter will provide a brief introduction of the recommendations pinpointing aspects for developing and assessing educational programs. We will provide a review of the existing feedback we have acquired during the IMIA site visits of accrediting educational programs at a worldwide level and discuss implementations issues. A brief overview of existing academic programs in Europe, North America and in other regions, especially for programs related to Nursing and to Nursing Informatics is provided. Finally, we will draw conclusions as how the IMIA recommendations may be required to be fitted into the specific needs of the Nursing Informatics and the needs of the Nursing professionals when they apply the recommendations to their academic and/or hospital/professional environments.

Keywords. Educational recommendations, nursing informatics

1. Introduction

Increasingly information systems are installed in hospitals, General Practitioners (GP) practices and other healthcare organizations. More and more activities such as registration of data in electronic health records, order entry, interpretation of images, different types of decision making and searching for medical knowledge are supported by information systems. Since patients are transferred between healthcare organizations communication between information systems is also becoming more important. Communication between these systems is only possible when semantic interoperability can be achieved, which requires standardization of the communicated messages.

Because of the ageing of populations the demand for cure and care will increase to such an extent that future healthcare workers cannot cope with the workload any more. So, it should be investigated how Information and Communication Technologies (ICT) solutions can reduce the workload of healthcare workers. An example is to monitor at home the health status of elderly people. Nurses and physicians usually can evaluate at a distance the condition of patients. This approach has led to less hospital admissions and reduces travel time of healthcare practitioners.

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Because of the above noted trends, there is an increasing need for informaticians to develop and design information systems but also to investigate new possibilities for the use of ICT in healthcare. At the same time, health informaticians should further develop the scientific foundation of the field.

The more information systems are installed in healthcare organizations, the more the users of these systems need to be knowledgeable about the benefits, but also the limitations of the use of these systems. In addition, relevant users must be able to express, in terms that are understood by software developers, which inefficiencies they experience in medical practice or where effective solutions for certain types of problems are needed. At least part of the end-users should be able to talk with software developers, understand solutions offered by them and judge the potential of these ICT solutions so that they can discuss the suggestions with their colleagues. This requires education and training. All end-users for example should be given the necessary education in health informatics at the level needed for carrying out their job (those nurses and physicians who in addition will be in contact with system designers will need more education in order to understand them and be able to judge offered solutions).

Usually, information systems are implemented and maintained by technically orientated personnel with a computer science background. They usually have limited insight in the problems of medical practice. It is well known that the communication between these ICT specialists and the medical staff is often not optimal. A solution may be to educate persons who are able to function as intermediaries between ICT specialists on the one side and physicians and nurses on the other. These may be health informaticians but also medical doctors or nurses who via additional education obtained the necessary informatics background (specialized healthcare practitioners). The specialized doctors and nurses may talk on the one side with the end-users and on the other side with health informaticians, who may in turn talk with the technically orientated informaticians. In this case there are two types of intermediaries. In other situations either health informaticians or (less frequently: since health informaticians with a medical or nursing background usually are less knowledgeable in the field) specialized healthcare practitioners may be the sole intermediaries. The International Medical Informatics Association (IMIA) Recommendations, to be discussed later, define the knowledge and skills that each of the above introduced groups should master.

Because of the growing need for health informaticians, educational programs in health informatics (both bachelor and master programs, but there are more master programs) increasingly focus on the professional practice rather than on research. These programs prepare graduates for careers oriented toward the use of best practices with respect to the design and development of information systems, their configuration and deployment in clinical and other settings, their integration into workflows, and the evaluation of their impact. Health informatics Master programs may have different focal points and deliver graduates with different kinds of expertise. These programs not only accept students with a bachelor in health informatics but also students with a background in medicine, nursing, biology, computer science, mathematics, physics, etc.

Especially in the bachelor phase, educational programs in health informatics introduce students extensively to medical and nursing subjects, so that health informaticians have, next to informatics knowledge and skills, also the necessary knowledge to support the medical staff in defining the requirements for new applications. Nowadays, also post-graduate master programs exist that have as goal to

specialize medical doctors and nurses in health informatics, sometimes using distance learning. In the United States (US) medical informatics is a medical subspecialty.

Knowledge about the use, benefits and limitations of information systems should be part of undergraduate nursing or medicine curricula.

The Recommendations on Education in Biomedical and Health Informatics of IMIA define the knowledge and skills necessary for creating different types of health informaticians [1]. Educational programs as described above use these recommendations when defining the contents of their health informatics curricula. In doing so, they also take the needs of the labor market into account in order to endow their students with employable skill sets.

When searching for an attractive program in health informatics, students take the international status of the higher education institution into account, because increasingly graduates may go to work in another country than their own. Educational institutions compete for students and therefore invite international experts to evaluate their programs so that they can advertise the results if the judgment is positive. Such an evaluation can become a costly business since usually not only the travel and accommodation costs for the experts have to be paid but also the experts have to be remunerated. IMIA has the potential to serve as accreditation agency [2, 3, 4]. The accreditation process can be less costly when experts from member countries of IMIA agree to carry out the peer review for free (expecting only remuneration of travelling expenses and accommodation).

The IMIA Recommendations on Education in Biomedical and Health Informatics are very important for a number of reasons. As mentioned above, the Recommendations are important for educational institutions when they plan to design a curriculum in Health informatics. The Recommendations allow them to design different types of program depending on the type of graduates they want to deliver. The recommendations are also necessary for enabling an international exchange of students and teachers and for establishing international programs and may encourage and support the sharing of courseware.

But also for accreditation the Recommendations are important. Since the health informatics curricula have various focuses, can be vocational or academic, a framework is necessary to judge whether the curriculum provides enough knowledge and skills for the type of graduates the program is delivering. The Recommendations are, therefore extensively used both for designing programs and for accrediting purposes.

In this book contribution among others the Recommendations and the Accreditation process are presented. We, as authors, have already published a lot about these topics. Therefore, we make use of earlier articles [1-6] to give our current readers a good overview of these topics.

2. Introduction to the IMIA Recommendations

Education in the field of health informatics is not available in all countries. In some countries health informatics curricula, both vocational and academic and for various types of healthcare professionals, are adequately available, in other countries this is hardly the case. It is now well recognised that the availability of specialists in health informatics and end-users who have knowledge of the benefits and limitations of the use of information systems has a positive influence on the quality and effectiveness of healthcare. A framework describing the possible subjects that should be part of health

informatics curricula and at which depth therefore will be of help in checking the quality of existing curricula and a guide for designing new curricula is therefore not a luxury. The IMIA recommendations for education [1] were designed just for this purpose. Existing educational programs have different focuses, depending on the type of institution that is delivering the education and the type of healthcare system existing in the country. Nevertheless, there is still quite a lot of overlap in the subjects that are taught. Due to this overlap, the development of a framework for recommendations becomes possible.

Around 2006 it was clear that the original version of the Recommendations had become outdated and should be revised and updated. In 2010, the revised version of the Recommendations [6] was published.

As shown above we can distinguish end-users from specialized nurses and doctors and health informatics specialists. The IMIA Recommendations specify major learning outcomes for the group of end-users and for the group of specialists:

- Learning outcomes for all health care professionals in their role as IT users: these learning outcomes should be included in all undergraduate curricula, leading to a health care professional qualification.
- Learning outcomes for health informatics specialists: these learning outcomes need to be included in all curricula that have the aim to deliver specialists in health informatics, leading to a qualification as specialist in health informatics, be it the group of health practitioners with additional knowledge and skills in health informatics or the group of specialists who follow a master course in health informatics.

Obviously, curricula for specialisation of a health care professional (post-graduate programs) or as a health informatics specialist (graduate programs), will show a varying depth and breadth of their learning outcomes.

The learning outcomes define the levels of knowledge and skills needed at the end of the study. The desired outcomes determine the contents of the educational components either in courses/course tracks in health informatics as part of non health informatics undergraduate programs or in the contents of dedicated programs in health informatics.

In the IMIA Recommendations the knowledge and skills levels are specified for four domain areas:

1. Biomedical and Health Informatics.
2. Medicine, Health and Biosciences, Health System Organisation.
3. Informatics/Computer Science, Mathematics, Biometry.
4. Optional modules from related fields.

Moreover for each of the recommendations it is stated at what level they should be taught (from introductory to advanced) both for the group of end-users and for the group of specialists. The latter group is more variable and therefore for each variety a different curriculum has to be specified.

3. Experiences with accreditation

In 2011, the IMIA General Assembly accepted a proposal to test a suggested accreditation procedure in a trial phase in which five institutions, spread over the IMIA regions, would volunteer to participate. It should be noted that the IMIA accreditation is an addition to national accreditation and does not replace it.

The accreditation procedure in the meantime has been tested and IMIA now offers to accredit educational programs in health informatics. The national accreditation procedures show a lot of commonalities. A quality assurance agency publishes which topics will be assessed and which criteria will be used. The institution prepares a self-assessment report covering the topics specified by the quality assurance agency. Usually a peer review team validates the contents of the report during a site visit and assesses the quality of the program. The peer reviewers usually are experts in the field that is covered by the program.. The IMIA accreditation procedure is similar.

The self-assessment report provides the information needed by the peer review team to evaluate the assessment criteria. According to the IMIA accreditation procedure the self-assessment report should answer the following six main questions:

1. What are the goals of the program for which the institute asks accreditation?
2. How are the goals implemented in a curriculum?
3. What is the size and quality of the staff?
4. Which facilities for teaching are available?
5. How does the institute guarantee the quality of the program?
6. Are the goals routinely reached?

The peer review usually comprises a site visit that may take from one to four days, during which the site-visit the peer review team (called site visit committee in the IMIA accreditation documentation) consults with the various stakeholders. The stakeholders for an educational program may range from the rector and dean to staff and student and alumni representatives, to employers of the graduates of the reviewed programme or institution. The site-visit committee may during the site visit ask for more information when needed.

After the site-visit the committee prepares a report containing an evaluation of the program and the final judgment. The IMIA Accreditation Committee sends the report to the institution or program with the question to correct factual errors if they are present in the report. Then the Accreditation Committee will make the final decision concerning accreditation or not.

During the trial period, IMIA accumulated substantial experience regarding the advantages of the process and ways of improving it. The different levels and orientations of the programs, the variety of cultures encountered, and the differences in implementation and infrastructural possibilities provided enough material to generalize and refine the accreditation procedure to facilitate its routine use in the future.

An assessment of the IMIA Accreditation process is reported elsewhere [2]. In [3] the experiences with the accreditation procedure were reported by the first educational program accredited by IMIA. Here we only mention an example of a change in the documentation that was necessary for theses written in the national language. The peer review team selects a number of theses that should be in their possession before the site visit. Theses usually prepared in the national language could not be understood by the reviewers. It was too time consuming or costly to translate the selected theses into English. Therefore, theses summaries in English were requested. However, the thesis

summaries did not provide a sufficient impression of the quality and content of the theses. Therefore, a translation of the Table of Contents was also requested and during the site visit an additional day was devoted to the discussion of the theses with the supervisors.

The common characteristics of all visits were the willingness of the volunteering institutions to accept the costs and time for accreditation, the overwhelming preparation and enthusiasm to participate shown at all levels of their hierarchy, and the acceptance of the final judgment of the committee, which included a number of recommendations for improvement.

An Accreditation Review Committee consisting of three independent IMIA Board members chaired by Reinhold Haux at that time, evaluated the accreditation reports [5] that were written during the trial period. The Committee came to the conclusion that:

- the site-visit committees have carefully studied the respective programs;
- they have documented their reviews and recommendations extensively and well-written in their reports;
- the IMIA Accreditation Review Committee fully supports all the recommendations;
- in case of reaccreditation, the actions for improvement, as expressed in the accreditation report, have to be put in practice. Otherwise, reaccreditation is probably not possible.

4. Educational programs in HI for nurses

There is a number of Biomedical and Health Informatics educational programs at academic institutions across the world. Detailed list of programs for Europe can be found at the EFMI website available at the WG EDU link [8]. The American Medical Informatics Association has a long tradition in establishing a database of educational programs available at US institutions [9]. Unfortunately, the tradition of IMIA to develop and hold a database of educational programs across the world is not available any more in the last ten years; therefore, there is a very important missing link of information available to those interested to have a global view in education in our field. However, from the available information and search, one may deduce that there is an increased number of programs especially in the field of Health Informatics and more lately in the field of Biomedical Engineering and Bioinformatics. Most of the programs are at the Master's level, which is quite reasonable, as you may specialise or convert professionals with different backgrounds to the Health Informatics discipline.

In most countries there is no Nursing Informatics specialisation or certification. So for a Nursing graduate the informatics skills and knowledge may be acquired at their undergraduate studies. From a brief review into the European nursing curricula it is not directly evident that nursing curricula include nursing informatics or health informatics courses/modules. One may find computer skills classes taught from outside the department faculty. Those classes are given to almost every other student at the University or Institution. Therefore, searching in European Institutions nursing curricula very few programs include nursing/health informatics courses. Also at those departments of nursing, where nursing/health informatics courses exist, there are even fewer mandatory courses in nursing/health informatics.

Since very few nurses are pursuing postgraduate studies due to the need either to work immediately, lack of nurses at the healthcare environment not allowing them to take a leave of absence for further studies, and/or sometimes lack of financial resources, emphasis should be given to the undergraduate curriculum to include a nursing informatics module/course as obligatory.

5. Recommendations for Nursing science and Nursing practitioners

So the movement of the 1990's and later, which in many ways was rather successful as Council of Europe provided mandate for health informatics courses implementation to be suggested as obligatory to all Medical, Nursing and other Health Sciences schools curricula, European Commission funded nursing specific actions such as Nightingale [10] and Telenursing/ Telenurse [11], seems now that it is fading out. One reason may be that the curriculum developers think that nowadays all students are already adequate users of computers so there is no need in a clinical school to introduce any more computer courses. This reason is not correct since Nursing/Health Informatics is a scientific discipline part of the Health Sciences curriculum and a computer skills requirement in the curriculum. This important difference has not yet penetrated into the traditional thinking of our fellow colleagues in a number of nursing departments or other health related departments including medicine.

6. Refocusing the Recommendations for Nursing

Studying the Recommendations and trying to view them from a specific professional viewpoint is the usual practice, whenever one wants to acquire a particular perspective.

Nursing is a clinical profession with particular needs and requirements regarding the Biomedical Medical Health Informatics (BMHI) field. It is well known that in both IMIA and AMIA, Nursing plays a very important and strategic role requiring special attention and the specialization of Nursing Informatics has a long history of accomplishments and specialized meetings and Conferences and attract special attention. The same goes with the educational requirements.

Therefore, we truly believe that a special attention should be paid to the IMIA recommendations when looked from a Nursing perspective. We have refocused specific skills in Table 1 where we underline the additional items that should be included to the already required skills.

Table 1. Modified table of Knowledge and Skills focused on Nursing

	Knowledge/Skills – Domain	Level	
		Nurse as User	NI specialist
1	**Biomedical and Health Informatics Core Knowledge and Skills**		
1.1	**Evolution of informatics** as a discipline and as a profession	+	+
1.2	**Need for systematic information processing** in health care, benefits and constraints of information technology in health care	++	++

	Knowledge/Skills – Domain	Level	
		Nurse as User	NI specialist
1.3	Efficient and responsible **use of information processing tools,** to support health care professionals' practice and their decision making	++	++
1.4	**Use of personal application software** for documentation, personal communication including Internet access, for publication and basic statistics	++	++
1.5	**Information literacy:** library classification and systematic health related terminologies and their coding, literature retrieval methods, research methods and research paradigms	++	++
1.6	Characteristics, functionalities and examples of **information systems in health care** (e.g. clinical information systems, primary care information systems, nursing information systems, etc.)	+	+++
1.7	**Architectures of information systems** in health care; approaches and standards for communication and cooper- ation and for interfacing and integration of component, architectural paradigms (e.g. service-oriented architectures)		++
1.8	**Management of information systems** in health care (health information management, strategic and tactic information management, NI management, IT governance, IT service management, legal and regulatory issues)	+	+++
1.9	Characteristics, functionalities and examples of **information systems to support patients and the public** (e.g. patient-oriented information system architectures and applications, personal health records, sensor-enhanced information systems)	+	++
1.10	Methods and approaches to **regional networking and shared care** (eHealth, health telematics applications and inter-organizational information exchange	+	++
1.11	Appropriate documentation and **health data management principles** including ability to use **health and medical coding systems,** construction of health and medical coding systems, nursing coding schemes	+	+++
1.12	Structure, design and analysis principles of the **health record** including notions of data quality, minimum data sets, architecture and general applications of the electronic patient record/electronic health record, including nursing records	+	+++
1.13	**Socio-organizational and socio-technical issues,** including workflow/process modelling and reorganization	+	++
1.14	Principles of **data representation and data analysis** using primary and secondary data sources, principles of data mining, data warehouses, knowledge	+	++
1.15	Biomedical **modelling and simulation**		+
1.16	**Ethical and security issues including** accountability of health care providers and managers and BMHI specialists and the confidentiality, privacy and security of patient data	+	++
1.17	**Nomenclatures, vocabularies,** terminologies, ontologies and taxonomies in BMHI	+	++
1.18	Informatics methods and tools to **support education** (incl. flexible and distance learning), use of relevant educational technologies, incl. Internet and World Wide Web	+	+
1.19	**Evaluation and assessment** of information systems, including study design, selection and triangulation of (quantitative and qualitative) methods, outcome and impact evaluation, economic evaluation, unintended consequences, systematic reviews and meta-analysis, evidence-based health informatics		++

	Knowledge/Skills – Domain	Level	
		Nurse as User	NI specialist
2	**Medicine, Nursing, Health and Biosciences, Health Systems Organization**		
2.1	Fundamentals of **human functioning** and biosciences (anatomy, physiology, microbiology, genomics, and clinical disciplines such as internal medicine, surgery, nursing, etc.)	+	+
2.2	Fundamentals of **what constitutes health,** from physiological, sociological, psychological, nutritional, emotional, environmental, cultural, spiritual perspectives and its assessment	+	+
2.3	Principles of **clinical/medical decision making, nursing assessment,** and diagnostic and therapeutic strategies	+	++
2.4	**Organisation of health institutions** and of the overall health system, interorganizational aspects, shared care	+	+++
2.5	**Policy and regulatory frameworks** for information handling in health care		+
2.6	Principles of **evidence-based practice** (evidence-based medicine, evidence-based nursing	+	+
2.7	**Health administration, health economics,** health quality management and resource management, patient safety initiatives, public health services and outcome measurement	+	++
3	**Informatics/Computer Science, Mathematics, Biometry**		
3.1	**Basic informatics terminology** like data, information, knowledge, hardware, software, computer, networks, information systems, information	+	+++
3.2	**Ability to use personal computers,** text processing and spread sheet software, easy-to-use database management systems	++	+++
3.3	**Ability to communicate electronically,** including electronic data exchange, with other health care professionals, internet/intranet use	++	+++
3.4	Methods of **practical informatics**/computer science, especially on programming languages, software engineering, data structures, database management systems, information and system modelling tools, information systems theory and practice		+++
3.5	Methods of **theoretical informatics**/computer science, e.g. complexity theory		++
3.6	Methods of **technical informatics**/computer science, e.g. network architectures and topologies, telecommunications, wireless technology, virtual reality, multimedia		++
3.7	Methods of **interfacing and integration** of information system components in health care, interfacing standards, dealing with multiple patient identifiers		++
3.8	Handling of the **information system life cycle**: analysis, requirement specification, implementation and/or selection of information systems, risk	+	+++
3.9	Methods of **project management and change management** (i.e. project planning, resource management, team management, conflict management,	+	+++
3.10	**Mathematics:** algebra, analysis, logic, numerical mathematics,		++
3.11	**Biometry, epidemiology,** and **health research methods**, including study		++
3.12	Methods for **decision support** and their application to patient management, acquisition, representation and engineering of medical knowledge; construction	+	+++
3.13	Basic concepts and applications of **ubiquitous computing** (e.g. pervasive, sensor-based and ambient technologies in health care, health enabling technologies,		+

	Knowledge/Skills – Domain	Level	
		Nurse as User	NI specialist
3.14	Usability engineering, **human-computer interaction**, usability evaluation, cognitive aspects of information processing		++

Nursing ontologies and classifications systems such as North American Nursing Diagnosis Association (NANDA), Nursing Intervention Classification (NIC), Nursing Outcome Classification (NOC), Omaha, and International Classification for Nursing Practice ICNP, and generic health care terminologies such as SNOMED CT should be included into any NI curriculum. Furthermore, nursing management skills is mandatory including change management, whereas patient safety nursing roles and patient advocacy are obligatory to be taught and discussed. Specific nursing information systems should also be added as required by both clinical environments and nursing management. The scientific nursing should be emphasized in relation to the nursing informatics field where osmosis may benefit both academic and clinical work. The need for professional nursing assessment and scientific evidenced based nursing may both gain support from the upcoming Informatics applications.

The additional items may be there at the revised Educational Recommendations but the authors feel that emphasis should be given in such a way that the obscured definitions become more obvious in the refocused for NI Educational Recommendations as mentioned in Table 1.

7. Conclusions and Discussion

We understand that education is a very powerful instrument for change in the society, the scientific domain and in the professional world. For many years Nursing has struggled to attain a scientific status across the world. This may be true for many years at certain countries such as US or Canada. However, for most countries including in Europe only in the last thirty years (almost one generation), Nursing has become and it has been accepted as a scientific field taught at University level.

In most of the Nursing schools modules or courses in IT skills exist, however, it is not evident from the search we have done that all programs in Nursing at undergraduate level teach Nursing Informatics. In addition, very few specific postgraduate programs exist in Nursing Informatics. Most programs at postgraduate level are called Health Informatics where graduate Nurses are accepted along with other interest medical/health sciences graduates. In those programs, specific modules/courses in Nursing Informatics are very rare.

It is therefore, a requirement to revisit the Educational recommendations and emphasize as clearly as possible the required skills and knowledge in BMHI as required from the Nursing scientific and professional viewpoint. In the modified table we have tried to provide a first effort to refocus the skills with nursing perspective.

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