

The International Partnership for Health Informatics Education



Lessons Learned from Six Years of Experience

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Summary

Objectives: To inform the medical and health informatics community on the rationale, goals, and the achievements of the International Partnership for Health Informatics Education – IPHIE, (IPHE), that was established at six universities in 1999.

Methods: We elaborate on the overall goals of IPHE and describe the current state of affairs: the activities undertaken and faculty and student experience related to these activities. In addition we outline the lessons we have learned over these past six years and our plans for the future.

Results: IPHE members first started to collaborate by supporting and encouraging the exchange of talented students and faculty and by establishing joint master classes for honors students. Following the success of these activities, new initiatives were undertaken such as the organization of student workshops at medical informatics conferences and a joint course on strategic information management in hospitals in Europe.

Conclusions: International partnerships such as IPHE take time to establish, and, if they are to be successful, maintaining leadership continuity is critically important. We are convinced that IPHE promotes professionalism of future medical informatics specialists. There will be a continuing growth of globalization in higher education. It will therefore become increasingly important to offer educational programs with international components.

Keywords

Health informatics, medical informatics, international educational exchange

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Introduction

In the next decades, health care will be significantly influenced by our aging society and put a heavier burden on delivering quality and efficient services. To provide better health care, information and communications technologies (ICT) will increasingly be needed. There is no doubt that parallel to this need for ICT, there will be an increasing demand for well-educated medical and health informatics specialists. To enhance the education of these future medical informatics specialists, we should offer them opportunities to share in the educational and research expertise and know-how of multiple universities and health care institutions. Today, international experience is widely regarded as an essential and integral part of a student's and faculty's training. Internationally educated medical informatics specialists may not only share their knowledge at international conferences, but many are willing to apply their expertise in international research projects, such as the Fifth and Sixth Framework Program of the European Commission [1]. As a byproduct, internationally trained medical informatics faculty and students may help to accelerate the dissemination of acquired knowledge and skills in the field and the promotion of medical informatics research results on a more global level.

In addition, international experience in the field will enhance the marketability and employability of future medical informatics specialists. Preparing medical informatics students for these roles, however, requires proactive initiatives. In this paper, we report on one such initiative: an International Partnership for Health Informatics Education – IPHIE (IPHE) that was established in 1999 [2, 3]. We describe the aims of this partnership, the universities involved, the activities undertaken and our experiences, the lessons we have learned and our projections for the future.

An International Partnership for Health Informatics Education

In 1999, a group of five universities, including the University of Amsterdam [4–6], the Universities of Heidelberg and Heilbronn [7–11], the University of Minnesota [12], and the University of Utah [13–15], agreed that internationalized studies should constitute an integral part of their educational programs. To stimulate this international orientation and education, they established IPHE [2, 3]. In 2002, the University for Health Sciences, Medical Informatics and Technology (UMIT [16, 17]) also joined the partner-

ship. The European universities offer medical informatics programs at the B. Sc., M. Sc. and Ph. D. levels [4-11, 16, 17]. The US universities offer the M. Sc. and Ph. D. degrees [12-15]. Table 1 gives an overview of the duration, the degrees and specific characteristics of each of these universities.

The overall aim of this co-operation was to form a network for training and educating medical informatics students on an international level to prepare them for leading positions in medical information and communication technology [2, 3].

These students are the next generation experts who will be responsible for the appropriate application of ICT to optimize complex information processing in health care. The sharing and dissemination of their knowledge and practical experiences with other students and faculty should help them to become more proficient in their field.

IΦE aims to achieve its mission by: 1) supporting and encouraging the exchange of students and faculty between universities, 2) organizing yearly joint master classes,

3) offering a joint European course on strategic information management, 4) organizing student workshops at international conferences, and 5) developing and sharing courseware.

By encouraging our students to become more internationally oriented, we hoped to prepare them for international positions in the medical informatics field and to enhance their marketability and employability.

Table 1 Overview of the characteristics of each of the programs of each of the partner universities within IΦE

| IΦE partner and programs: | Degrees offered: | Program length: | Program characteristics: |
|---|------------------|-------------------|--|
| University of Amsterdam: Medical Information Sciences | B. Sc. | 3 years | Founded: 1987 Intake: high school graduates Orientation: Health Information Sciences/ Informatics |
| | M. Sc. | 2 years | Founded: 1987 Intake: Baccalaureate graduates in biomedical informatics, physicians, informaticians Specializations: Medical Decision Support, Health Care Management, Health Information Systems |
| | Ph. D. | approx. 4 years | Founded: 1981 |
| Universities Heidelberg and Heilbronn: Medical Informatics Health Information Management | B. Sc. | 4.5 years | Founded: 1972 Intake: high school graduates Orientation: Medical informatics- total spectrum Specializations: Management in Health Care, Health Information Systems, Biomedical Signal and Image Processing, Medical Decision Support, Medical Biometry |
| | M. Sc. | | |
| | Ph. D. | approx 3–4 years | Founded: 1984 |
| | M. Sc. | 15 months | Founded: 2000 Intake: physicians |
| UMIT: Biomedical Informatics | B. Sc. | 3 years | Founded: 2001 Intake: high school graduates Orientation: Biomedical/ Health Informatics |
| | M. Sc. | 2 years | Founded: 2001 Intake: Baccalaureate graduates in biomedical informatics, physicians, informaticians Specializations: Bioinformatics, Health Information Management, Medical Informatics |
| | Ph. D. | approx. 3–4 years | Founded: 2001 |
| University of Minnesota: Health Informatics | M. Sc. | 2 years | Founded: 1973 Intake: Baccalaureate graduates Specializations: Health Informatics Research Applications, Bioinformatics |
| | Ph. D. | 4+ years | Founded: 1973 |
| University of Utah: Medical Informatics | M. Sc. | 2 years | Founded : 1964 Intake: Baccalaureate graduates, physicians, nurses Specializations: Health Information Systems, Public Health Informatics, Bioinformatics/Genetic Epidemiology, Medical Imaging |
| | Ph. D. | 4+ years | Founded: 1964 |

Experiences within IΦE

Student and Faculty Exchange

IΦE encourages student and faculty exchanges among partner schools. With the student exchange program, we aim to tailor students' master thesis work to their individual interests and to offer optimal challenges to deepen their knowledge and skills in a specific medical informatics subject. Students may, for example, be interested in a research topic which is not a main theme in the research program of their home university but is in the research domain of another IΦE partner university. The student exchange program offers these students the option to carry out (part of) their master thesis project at the university that is well-known for its expertise in a specific research area. For example, in the past, the University of Minnesota was far ahead of the University of Amsterdam in its research in the area of telemedicine. Consequently, Amsterdam students interested in telemedicine fully subscribed to telemedicine projects at the University of Minnesota. Both universities have covered public health informatics as research themes. Such exchanges have led students to carry out part of their research at their home site and part of their research at a host university. Thus these students are offered the opportunity to profit from both worlds and bring home new ideas that may add to their knowledge and final research outcomes.

The objective of the faculty exchange program is to deepen students' knowledge of specific medical informatics subjects by having IΦE faculty members that are expert

in these subjects teach at another university program. For example, faculty members of the University of Heidelberg and UMIT have been teaching about hospital information systems at the Amsterdam program, faculty members of Amsterdam have been teaching about the formalization and implementation of clinical guidelines at the Heidelberg program and on the computerized patient record at the UMIT program.

Faculty receive the status of visiting faculty at the hosting school, and students have tuition fees waived. For visiting student research projects, a faculty member of the hosting institution serves as a thesis research advisor. Since its inception in March 1999, IΦE had 17 student and 29 faculty exchanges between the partners (see Tables 2 and 3).

After six years of the IFE exchange program it is now clearly understood by students at each of the Universities. As a consequence the process of application and international exchange has become easier. Typically, a student must first contact a faculty member at his/her institution. The student applicant's acceptance into the program is based on an informal assessment of personality and ability, and also on the topics and scope of the student's project. Local faculty members then help facilitate student contact and project definition with the partner institution. For students coming to the United States (US), the US visa application process is often a lengthy and stressful experience; on the other hand, most European students (depending on their nationality) who are going to a European Union school can easily transfer when their project definition is sufficiently advanced. Foreign students who are studying in the United States have had difficulty in receiving permission to attend a European partner school in the IΦE program. University administrations can assist in the paperwork to get admission to their respective country. The personal part of the exchange process must address nationality, academic and professional achievements, security and financial risks. Typically the candidates must have sufficient funding from a trusted source and proof of health insurance to come to a US institution. Persons temporarily at a US university may have access to

Table 2
Student movements between IΦE partners, 1999-2004

| | | Europe | | | US | |
|--------|------|----------------------|----------|----------|----------------------|----------------------|
| | | AMS | H/H | UMIT | MN | SLC |
| Europe | AMS | | 1999 (1) | 2003 (1) | 2000 (2) 2001 (1) | |
| | H/H | 2000 (1) 2003 (1) | | | 2000 (1) 2003 (1) | 2002 (2) 2003 (4) |
| | UMIT | | | | | |
| US | MN | | 2004 (1) | | | |
| | SLC | | 2002 (1) | | | |

AMS = Amsterdam, H/H = Heidelberg/Heilbronn, UMIT = Innsbruck, MN = Minneapolis, SLC = Salt Lake City

Table 3
Faculty exchange between IΦE partners, 1999-2004

| | | Europe | | | US | |
|--------|------|----------------------|--|----------------------------------|----|-----------|
| | | AMS | H/H | UMIT | MN | SLC |
| Europe | AMS | | 2001 (3) 2002 (2) 2003 (2) 2004 (1) | 2002 (2) 2003 (3) 2004 (1) | | |
| | H/H | 2001 (3) 2002 (2) | | | | 2002 (1)* |
| | UMIT | 2004 (1) | 2002 (2) 2003 (1) 2004 (1) | | | |
| US | MN | 2004 (1) | 2004 (1)* | | | |
| | SLC | 2004 (2) | | | | |

AMS = Amsterdam, H/H = Heidelberg/Heilbronn, UMIT = Innsbruck, MN = Minneapolis, SLC = Salt Lake City, * = sabbaticals of several months.

the university health plans for students, but must pay for the health insurance.

As already discussed, graduating from one's home university may be combined with research at a partner institution in a variety of ways, from short stays to full-length graduation projects in the host institution. The importance of guidance by academic faculty at home and host sites has become apparent.

More European students have come to the United States than Europeans going to the United States. The imbalance of movements between the American and European institutions is likely due to perceived language problems by the American students in Europe. However, funding issues and duration of student stays have also been important factors. For example, a European master thesis is part of a graduate curricu-

lum and may last only one year, while in the United States a M. Sc. degree with thesis preparation typically takes two years and research for the Ph. D. dissertation typically takes three to five years. A major source of funding for the American medical informatics students at the University of Minnesota and University of Utah is from National Library of Medicine (NLM) training grants. These NLM training grants have funding arrangements for US students completing their training at a US university. However, there is currently no equivalent funding source for foreign students. For students moving into or out of Heidelberg/Heilbronn there is a dedicated yet limited public (state) funding resource – the Baden-Württemberg-Stipendium (Baden-Württemberg scholarship).

Personal contact is a major factor in stimulating student exchange: Exchanged visits of student groups and faculty exchanges among partner schools in the past have been the most important factor for achieving student mobility.

Master Classes

The idea of “Master Classes” was borrowed from the field of the performing arts, where experts coached novices to achieve mastery in their area of expertise. IΦE offers master classes in health informatics to provide an integrative forum for honors students [18]. These master classes include comparative international views of health care systems, opportunities for faculty/student interaction and promotion of professionalism. Starting in 1999, the week long master classes have been offered each summer to selected honors students from each of the participating medical/health informatics programs. The master classes have now been hosted once by each of the IΦE sites for up to four honors students and two faculty members from each of the institutions. Attendance has ranged from 25 to 30 participants each year. In addition to the faculty members and students from each program, invited experts who focus on topics important to the host institution have also participated. Honors students from the partner programs apply their professional skills in small groups where they discuss, analyze, and critique selected topics from their own research or from the International Medical Informatics Association’s (IMIA) Annual Yearbook of Medical Informatics. Frequently the master class is arranged in conjunction with an international conference such as MEDINFO or MIE that provides further opportunities for students and faculty to participate in panels and workshops. At each of the master classes there have also been opportunities for travel, sightseeing and visiting local health care facilities. A site visit to the university hospital organizing the master classes to showcase the hospital information strategy is always part of the master class program. Overall, systematic evaluations of the master classes have shown, among other things, that students highly appreciated the

master class lectures, felt that they improved their professional knowledge and skills by the international exchanges during these classes, and had much better insight into what is going on in the medical informatics field worldwide as a result of the master classes [18]. The high level of interaction among students and faculty from different institutions and countries has provided an opportunity for important student and faculty interchange and has fostered international collaborations and better understanding of the challenges of sharing informatics progress internationally.

Joint International Course of the European Partners

Considering the global problems and solutions that national health care systems are increasingly forced to deal with [19, 20], including medical informatics problems and solutions, it was decided that the European students should be trained to meet the demands of an increasingly international health care environment. For this reason, since 2001, a joint international course on strategic information management in hospitals has been offered for medical informatics students from the University of Amsterdam, as well as medical informatics and health information management students from the Universities of Heidelberg/Heilbronn. Starting in 2002, medical informatics students from the M. Sc. program of UMIT have joined in the partnership and international course.

The course aims to answer the following questions:

- Why is systematic information processing in hospitals important?
- How are hospital information systems designed and why?
- What are attributes of good hospital information systems?
- How can we strategically manage hospital information systems?

The objective is to provide our students with the knowledge and skills necessary to begin professional, practical work after graduation and to be able to do research in the field.

The annual course is now organized into three blocks. Block 1, the first part of the course, is taught separately by teachers of the respective programs either in Dutch or in German, using the same e-learning platform and courseware [21-23]. This block also includes site visits in the respective university medical centers (i.e. Amsterdam, Heidelberg, and Innsbruck) and a presentation of the architectures and infrastructures of their hospital information systems. Finally, students are introduced to their exercises. The students are assigned to groups, typically consisting of students from all three countries. In Block 2 students start to work on their assigned projects. In Block 3 students and faculty meet for approximately three days at one institution (in 2001 they met at the University of Heidelberg, in 2002 at the University of Amsterdam, in 2003 at UMIT in Innsbruck and in 2004 at the University of Heidelberg again). During this block the final part of the course is jointly taught to all students in English. Students do group work to jointly finalize their assigned exercises and prepare their presentations. Finally they present the results of their exercises to the faculty members and students participating in the course [22, 23].

Thus far, all student evaluations of these courses have been positive. Besides the benefit of working jointly with students from other countries, the combination of presenting knowledge about hospital information systems, and their clinical application in different university medical centers (with differing health care systems), has found to be very helpful. The strategy was found to be more helpful than a regular lecture series at their home university [23].

Student Workshops

It was felt that sharing and disseminating research results and practical experiences with an international audience of medical informatics specialists would help students become greater experts in the field. To this end, four student workshops at international medical informatics conferences have been held: the first, in 2000, as part of MIE in Hanover, the second, in 2001, as part of MEDINFO in London, the third at the 2003

MIE conference in Saint Malo, and the fourth in 2004 as part of MEDINFO in San Francisco. A total of 24 graduate students in the university programs that form IΦE presented their thesis work to an international audience at one of these conferences. Typically, students reported they have discovered new ideas as they presented their thesis work. For instance, as a result of the suggestions put forward by the audience, students have found additional literature related to their research topic and have refined their research methodology. As a byproduct of these workshops, students have also made new contacts in their research field.

In addition, the international medical informatics audience has been informed about research issues addressed by newcomers in the field. Overall, these workshops have promoted the discussion and exchange of ideas between these newcomers as well as the established international medical informatics community.

Lessons Learned

A major objective of IΦE is to form a network for training and educating students on an international level and to have them become more proficient in the field by sharing in the knowledge and practical experience of faculty members and students of the other partner universities. Of each of the activities undertaken the evaluation results show, overall, that we succeeded in our goal. The international aspects of each of the IΦE activities are highly valued by both students and faculty members. Students report that they really improved their knowledge and professional skills as a result of the IΦE program [18, 23].

The student exchange program has increased our students' opportunities to tailor their education to their individual needs, while at the same time they become acquainted with international developments in medical informatics research. With the faculty exchange program, we have enhanced medical and health informatics education by making faculty members' expertise available to students of other IΦE partners.

We have learned that regular joint courses are possible and can be beneficial. Our experience with the international course on strategic information management in hospitals has shown that working jointly on exercises with students from other countries is very helpful in identifying the pros and cons of the various architectures and infrastructures of the hospital information systems at academic hospitals in different countries. This comparative analysis of the hospital information management strategy of these three European hospitals contributed to our students' in-depth understanding of the strategic information management in these hospitals and gave them new insights into ways of addressing common concerns in this respect. The international course is now fully integrated into the three medical informatics university programs of the participating European IΦE sites and credited. One problem which still remains is that each university has its own or national regulations for student credits and examinations. As a result, for example, we are not planning to extend this course to students at the American schools, because of problems of funding and of student credit exchange. In the future, we may open the international course to students in other European medical informatics programs. In future, the course may develop in a European post M. Sc. course for other professionals in the health care field, such as health care professionals who are heading for a management position or for hospital managers.

The joint master classes for honors students from all our institutions have been outstanding. The twin aims of these classes are: 1) to enhance the participants' knowledge by offering additional 'master' lectures that cover in-depth medical informatics topics, and 2) to have international students learn from each other by discussing, analyzing and critiquing topics from their own research and from medical informatics articles. The second aim has been easily reached. Students see great personal benefit in these international exchanges and report improvements in their professional knowledge as a result of these exchanges. The first aim has been more difficult to achieve. Here we have noticed that, although our curricula had many similarities, there were also con-

siderable differences. What students of one program knew was often new to students of another program. The Amsterdam University program's focus is less on mathematics than the other programs. As a consequence, the Amsterdam students needed some additional lectures in mathematics to be able to understand an advanced master class on image processing. We need to reassess the conceptual level of medical informatics in our curricula in light of the contents of the advanced lectures offered in the master classes. Furthermore, master class lectures have concentrated mainly on expertise related to the research programs of the hosting institution; further opportunities must be found for content addressing the differences in health care systems across nations.

We can recommend setting up international partnerships of educational programs in the field of medical and health informatics, such as IFE. Our six years of experience have shown us that international collaboration takes time to establish and leadership continuity is critically important. Funding of our students and faculty for their exchange is also an ongoing challenge. Since the tragedy of September 11, 2001, we are now faced with visa problems for some of our students. Overcoming these challenges is critical for international collaborations in higher education and in research in general.

Future Projections

In accordance with the IMIA goals ([24, 25], see also [26-28]) the members of our partnership are convinced that there will be a continuing increase of globalization in higher education, in spite of language barriers and differing national cultures and laws. It will become increasingly important to have educational programs with global offerings [24]. Schools forming such partnerships will now likely have an advantage over others, as institutions compete in a global educational market.

We aim to enhance medical and health informatics education and innovation, first in our own medical informatics university programs, but in future on a more inter-

national scale. At the moment, our international partnership, IΦE, consists of schools in Europe and North America. In future, we will consider partnership of schools from other continents. In this way, we hope to fully exploit the potential of international education. We will make maximum use of the advantages of modern information technology, in particular of e-learning platforms, but will not abandon a substantial amount of classroom education and close, personal student-faculty mentoring relationships. We also want to create specialized courses, offered by one of our participating universities, more available to all of our students.

As a consequence we have had to consider tuition and “transfer of credit” between institutions. In addition, the challenges of integrating faculty members across the six institutions as ‘affiliated faculty’ have become an increasingly relevant issue.

In spite of these difficulties, the required changes in our educational strategies will be kept in perspective so we do not lose sight of our intention to provide a high quality “international” education. Education at the university level is hardly possible without an integrated research environment. Strong links to integrated clinical and basic research facilities are of equal importance to our faculty and students.

Discussion

In clinical health care, efficient information management is vitally important to assure high quality and cost effective clinical patient care. In this context, the need for medical informatics specialists to support effective information processing in health care, through use of ICT, has become clear. Since medical informatics is a relatively new discipline, we are convinced that specialists should be able to share and profit from each others’ knowledge and experience on an international scale. Our international exchange program IΦE has been able to supplement the students’ medical informatics education by providing exposure to: 1) research programs and the specific

faculty expertise from other universities, 2) knowledge of other international students’ research work and their accomplishments and 3) other international health care systems, and health care organizations’ information and communication architectures and infrastructures.

We believe that IΦE promotes professionalism of future medical informatics specialists by exchange of knowledge and educational experience in the medical informatics field across both national and international borders. Other universities have also co-operated in joint projects to promote multidisciplinary and international approaches in their educational programs [29-32]. In particular, the IT-EDUCTRA project of the Telematics Application Program produced teaching materials used by both educational institutions and health professionals to remedy the knowledge gaps of these professionals with respect to health informatics [31]. Health care management curricula have benefited from international collaboration by having advanced information technologies introduced into their programs [32]. A successful example of international collaboration in health informatics is the European M. Sc. postgraduate diploma in health informatics at the University of Surrey, which is offered by faculty of European universities [33]. The European Federation for Medical Informatics of the IMIA has encouraged high standards in education by advancing international cooperation and dissemination of knowledge through its working groups [34]. In 2000, one of these groups, the Working Group on Education, succeeded in formulating recommendations for accreditation of medical informatics programs [24]. The newest regional organization of the IMIA, the Asia Pacific Association for Medical Informatics, aims to advance health informatics in the Asia Pacific region [35]. A major goal of all these initiatives is to accelerate the development of educational programs in medical informatics and to educate a broad range of professionals, including school graduates, computer engineers, health care professionals (clinicians), and medical informatics specialists. In some of the international programs mentioned, course materials were prepared or offered by faculty of

various universities in order to fully exploit partners’ expertise.

For the most part, in these programs, students acquire their fundamental medical informatics knowledge at one educational institution. Our IΦE international partnership hopes to continue to stimulate students to become more internationally oriented by having them prepare their thesis abroad, by attending our international master classes, by having the European students attend the course on strategic information management in hospitals and by having them present their research master thesis work to an international audience. In addition, faculty exchange within IΦE will deepen students’ knowledge of medical informatics topics, advance their methodological skills and teach them to appraise new research areas.

In the future, IΦE may offer these and other opportunities for additional interactions among students, faculty and institutions to contribute to enhancing professionalism in the medical informatics field. We have discovered that many exciting experiences occur when people in the same discipline from different countries can meet, interact and share research knowledge.

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References

1. Health and telemedicine projects co-funded by the European Commission. http://www.ehto.org/ht_projects/. Last access: October 04.
2. Jaspers MWM, Gardner RM, Gatewood LC, et al. IΦE: An international partnership in health informatics education. In Hasman A, Blobel B, Dudeck J. et al. (eds.). *Medical Infobahn for Europe*. Amsterdam: IOS Press; 2000, 549-53.
3. International Partnership for Health Informatics Education. <http://www.iphie.org>. Last access: October 04.
4. University of Amsterdam. <http://www.kikpage.org>. Last access: October 04.
5. Jaspers MWM, Limburg M, Ravesloot JJ. *Medical informatics in Amsterdam: research and edu-*

- cation. In: Haux R, Kulikowski C (eds.). *IMIA Yearbook of Medical Informatics 2001*. Stuttgart: Schattauer; 2001, pp. 117-24.
6. Jaspers MWM, Fockens P, Ravesloot JH, Limburg M, Abu-Hanna A. Fifteen years medical information sciences: the Amsterdam curriculum. *Int J Med Inf* 2004; 73: 465-77.
 7. University of Heidelberg/Heilbronn. <http://www.med.uni-heidelberg.de/mi/>. Last access: October 04.
 8. Leven FJ, Haux R. Twenty five years of medical informatics education at Heidelberg/Heilbronn: discussion of a specialized curriculum for medical informatics. *Int J Med Inf* 1998; 50: 31-42.
 9. Leven FJ, Knaup P, Schmidt D, Wetter T. Medical informatics at Heidelberg/Heilbronn: status – evaluation – new challenges in a specialised curriculum for medical informatics after thirty years of evolution. *Int J Med Inf* 2004; 73: 117-25.
 10. Knaup P, Frey W, Haux R, Leven FJ. Medical informatics specialists: what are their job profiles? Results of a study on the first 1024 medical informatics graduates of the Universities of Heidelberg and Heilbronn. *Meth Inf Med* 2003; 42: 578-87.
 11. Haux R, Schmidt D. Master of science program in health information management at Heidelberg/Heilbronn: a health care oriented approach to medical informatics. *Int J Med Inf* 2002; 65: 31-9.
 12. University of Minnesota. Graduate programs in health informatics. <http://www.hinf.umn.edu/aboutus/msphd.html>. Last access: October 04.
 13. University of Utah. <http://www.med.utah.edu/medinfo/training.html>. Last access: October 04.
 14. Gardner RM. University of Utah medical informatics research and training program, In: Haux R, Kulikowski C (eds.). *IMIA Yearbook of Medical Informatics 2001*. Stuttgart: Schattauer; 2001, pp. 103-11.
 15. Patton GA, Gardner RM. Medical informatics education: the University of Utah experience. *JAMIA* 1999; 6: 457-65.
 16. University for Health Sciences, Medical Informatics and Technology (UMIT). <http://www.uit.at>. Last access: October 04.
 17. Haux R. Biomedical and health informatics education at UMIT– approaches and strategies at a newly founded university. *Int J Med Inf* 2004; 73: 127-38.
 18. Gatewood L, Limburg M, Gardner R, et al. International master classes in health informatics. *Int J Med Inf* 2004; 73:111-6.
 19. Ball MJ, Garets DE, Handler TJ. Leveraging IT to improve patient safety. *Methods Inf Med* 2003; 42: 503-8.
 20. Hasman A, Safran C, Takeda H. Quality of health care: informatics foundations. *Methods Inf Med* 2003; 42: 509-18.
 21. Haux R, Winter A, Ammenwerth E, Brigl B. *Strategic information management in hospitals. An introduction to hospital information systems*. New York: Springer; 2004.
 22. Haux R, Ammenwerth E, Ter Burg WJ, Pilz J, Jaspers MWM. An international course on strategic information management for medical informatics students: aim, content, structure, and experiences. *Int J Med Inf* 2004; 73: 97-100.
 23. Jaspers MWM, Ammenwerth E, ter Burg WJ, Kaiser F, Haux R. An international course on strategic information management for medical informatics students: the international perspectives and evaluation. *Int J Med Inf* 2004; 73: 807-15.
 24. Recommendations of the International Medical Informatics Association (IMIA) on education in health and medical informatics. *Methods Inf Med* 2000; 39: 267-77.
 25. Lun KC. Challenges in medical informatics: perspectives of an international medical informatics organization. *Methods Inf Med* 2002; 41: 60–63.
 26. Douglas JV, Hovenga EJ. Health and medical informatics competencies: call to participate in updating the IMIA recommendations. *Methods Inf Med* 2002; 41: 86-8.
 27. Lindberg DAB. Medicine in the 21st century: global problems, global solutions. *Methods Inf Med* 2002; 41: 253-6.
 28. Kulikowski CA. A micro-macro spectrum of medical informatics challenges and opportunities: from the informatics of molecular medicine to that of transforming health care in a globalizing society. *Methods Inf Med* 2002; 41: 20–24.
 29. Zavarová J, Engelbrecht JH, Van Bommel JH. Education and training in medical informatics, statistics and epidemiology in EuroMISE. *Int J Med Inf* 1997; 45: 3-8.
 30. Mantas, J. M. Sc. course in health informatics: an inter-university cooperation success story in Greece. *Stud. Health Techn Informatics* 2000; 57: 40–45.
 31. Hasman A. Education and training in health informatics: the IT-EDUCTRA project. *Int J Med Inf* 1998; 50: 179-85.
 32. Pudil P, Paterson M. Improving the quality of decision-making in health care management: a project report from the Nevada/ Bohemia health management education partnership. *J Health Adm Educ* 1999; 16: 255-62.
 33. University of Surrey. <http://www.eihms.surrey.ac.uk>. Last Access: October 04.
 34. Naszlady A. Contribution of EFMI to development of medical informatics. *European Federation for Medical Informatics. Med Arh* 1999; 53: 11-2.
 35. Cesnik B. The future of health informatics. *Int J Med Inf* 1999; 55: 83–85.

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