Editorial

Perspectives of Medical Informatics: Advancing Health Care Requires Interdisciplinarity and Interoperability

Special Topic on the Occasion of the 35th Anniversary of the Heidelberg/Heilbronn Curriculum of Medical Informatics

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More than ever before, health and medical informatics is an exciting and challenging interdisciplinary field dealing with many current and prospective problems. This is being reflected in various examples: developments in medicine and health care (e.g. sensor-enhanced health information systems [1] or genomic medicine [2]), changes of our social environments and networks of modern living. New technologies, processing capabilities and communication media like the Internet have been developed for efficient and novel problem solutions and support. These technical and methodological innovations demand for experts with a deep knowledge and understanding for identifying adequate application scenarios. Optimal integration of recent technologies is one of the crucial prerequisites to face the requirements and challenges of the next years [3].

Going back to the roots of medical informatics of the last century’s late sixties and early seventies leads us to the very first application areas and beginnings of computers and programs in hospitals. Obviously, people concerned with the needs and procedures of information processing in daily routine realized soon what tremendous advantages computer support could bring about. It is remarkable that educational programs in medical informatics had already started even before computer science became an established subject in technical universities in Germany. These are the first pioneers’ merits of more than 35 years ago who had a vision and the power, creativity and sense of reality to design and implement curricula in medical informatics.

This was the reason for the celebration of the 35th anniversary of the Heidelberg/Heilbronn medical informatics program [4]. We strive to do as our pioneers did: to look ahead and face the problems and challenges being offered in order to maintain and create a humanized and socially compatible health care system with all its different structures, entities and tasks.

Against this background, we invited internationally esteemed speakers from Germany, Austria, Sweden, and the USA to describe the current status of selected important themes of medical informatics and to present their views, expectations and recommendations for the future. They reported and discussed about innovations and perspectives in the fields of bioinformatics, medical image and signal processing, ambient-assisted living, intra- and interinstitutional information systems, clinical research networks and health telematics (eHealth). This special topic of Methods of Information in Medicine represents the peer-reviewed collection of their papers which reflect the high degree of interdisciplinarity and interoperability. We hope...
that this topic contributes to the important and required debate on the future of medical informatics in an international audience.

Kulikowski and Kulikowski start the discussion of the present and upcoming challenges for biomedical and health informatics [5] to advance translational medicine. They define translational medicine as "... the application of basic biological results ... to health and disease processes" ('from bench to bedside'). The first published results all rely on bioinformatics methods for analysis. The reverse translation 'from bedside to bench' seems to become necessary, too. Kulikowski and Kulikowski consider them as the greatest, largely unaddressed challenge which rises new opportunities also for health informatics. Personalization of healthcare should be enabled by integration of genomic, clinical, and other information taking technoscientific and human-ethical perspectives into account.

In the second paper Handels and Ehrhardt identify future trends of medical image computing [6]. Innovative methods in this field enable insights into the patient's image data and have the potential to improve patient care with regard to diagnostics as well as to therapy, e.g. software-assisted and navigational surgery. In the near future, optimized application-specific systems have to be developed and integrated into the clinical workflow. Enhanced computational models are needed for image analysis and virtual reality training systems. The development of image analysis systems is a highly interdisciplinary process calling for methods of different scientific fields to be adapted and combined. Multimodal image data and biosignals should be merged to achieve an optimal set of individual data for decision making. Another exciting perspective is that of advancing methods for 4D medical image computing, particularly for functional examinations.

Witte and colleagues consider biosignal processing also as a highly integrative concept [7]. They observe an overlap between image, signal processing and bioinformatics which can lead to a more innovative use of the methodologies of each field. From their point of view the five major trends in signal analysis are the following: 1) time-variant signal analysis approaches, 2) multivariate techniques for medical signal analysis, 3) description of the dynamic system characteristics with time-frequency methods and combinations of time-variant linear and nonlinear approaches, 4) data-related models and simulations for an adequate interpretation of the increasing complexity of results and 5) processing and fusion of high-dimensional and multimodal data.

Medical informatics contribute to the innovative and multidisciplinary field of ambient-assisted living (AAL). Koch and Haux summarize the state of the art in AAL and present examples of how health-enabling and ambient-assistive technologies could improve the quality of life and efficiency of health care in aging societies [8]. These technologies will change the living processes of patients/citizens and the work processes of health and social care professionals. Therefore, well-designed evaluation studies are necessary to analyze the feasibility and the outcome of the technical solutions in a social context and in relation to individual needs. The authors identify not only the construction of adequate sensors as a major aspect for future research, but also the design of sensor-enhanced personalized health information systems and the integration with electronic health records. Due to the breadth of the field of AAL and to the changes that might arise with it, more aspects like new models for reimbursement as well as user acceptance and privacy are discussed as future research topics.

Besides all these exciting innovations and highly available technical solutions we still observe basic problems with clinical processes: Multiple recording of data for clinical and research purposes is inefficient and can lead to low data quality for reports and research. According to Prokosch and Ganslandt [9], "reuse of such data for data warehousing and research purposes is still very rare". The exploitation and analysis of the data in hospital-wide electronic health records for clinical research and management decisions might lead to a higher technology acceptance. Therefore, the authors summarize in their paper current activities in the United States of America and the European Union in data warehousing, data retrieval and linking health and medical informatics to translational research and they analyze how the data in the electronic medical record can be reused. As three new challenges for medical informatics they identify 1) data warehousing and data mining, 2) establishing an IT infrastructure for clinical research, and 3) linking electronic medical records with clinical research databases.

In their paper Ohmann und Kuchinke take up the necessity of information technology (IT) infrastructures for clinical research networks [10]. Horizontal networking connects different research units whereas vertical networking is the bridge between clinical research and medical care. In the last decade the number of research networks increased and medical informatics solutions are necessary to design and support their IT infrastructure. The authors identify interoperability and integration as key features for success. Therefore, they introduce the divergence of standardization efforts which are relevant in the context of supporting clinical trials with IT. There is a variety of tools available that support single tasks of the complex process of a clinical trial, e.g. clinical data management systems or systems for electronic data capture. But there are only few tools which cover the full process of a trial, not to mention networked research. Also the acceptance of electronic sources for clinical research and of the concept of open research are prerequisites to advance the field.

Of course not only research is highly interlinked but also medical care. According to Pfeifer's paper [11] integrated care concepts need to be supported by information and communication technology (ICT). The demands of modern integrated health and social care systems have to be transformed into user-friendly, secure and efficient ICT solutions. To connect, communicate and cooperate in health care by using ICT is called eHealth or health telematics. Electronic health records are essential for central eHealth solutions. They have to evolve as a patient-centered integrated system which can be used by the patient himself who will be able to take over responsibility for his own health. An active role of the patient in health care processes and prevention will be crucial for modern health care systems. Therefore the usability of eHealth applications has to be improved from a patient's point of view. The author summarizes interoperability, personalization, patient centering, knowledge management, usability, data processing and protection as key elements of future medical informatics research.
Winter derives changes and challenges of medical informatics [12] by analyzing current trends in medicine in health care, information systems and information management. The author's examples for trends in medicine are patient-centered medicine, evidence-based medicine, increasing competition among care providers and molecular diagnostics. As trends in information systems service-oriented architectures (SOA) and 'Green IT' are highlighted. Trends for organizing structures, services and processes in information management departments are Control Objectives for Information and Related Technology (COBIT) and the IT Infrastructure Library (ITIL) which lately are being cosidered in medicine and health care, too. Up to now the concepts of organizing information management are limited to a single institution. They are not directly applicable to network structures. From these trends challenges arise for research in medical informatics: IT service management in small health care units, reference models, trustworthy architectures and service-oriented architectures. The author's conclusion puts the discussion of all the papers in our special topic in a nutshell: "medicine and health care need medical informatics as a scientific research discipline".

Therefore, we need a workforce which is well educated in medical informatics and which is prepared to contribute to important changes in health care and social systems and to support them with well designed ICT-solutions. Against this background, we introduce the evolution of the medical informatics program at Heidelberg and Heilbronn, Germany, which is now more than 35 years old [13], in the final paper of our special topic. In several curriculum revisions we have tried to keep pace with the challenges of new developments in health care and medicine. We have established a consecutive bachelor/master program for an informatics-based approach to health informatics that qualifies the graduates to work in the field of health and medical informatics as well as in the field of informatics. Especially the elective modules for the advanced students are strongly oriented according to future trends of medical informatics as introduced in this special topic. We strengthen the topics telemedicine, bioinformatics and information management in both programs and introduced the topic digital media in the master program. The program adheres to the IMIA recommendation of education in health and medical informatics as well as to the Bologna declaration. A high-quality education of medical informatics students will be crucial to meet the challenges which are expected for medical informatics in the future.

All authors emphasize the fact that interoperability is essential for medical informatics as a highly interdisciplinary field. Health and medical informatics professionals have to be carefully prepared for working in multidisciplinary teams [14, 15] and for providing IT solutions for various stakeholders. Especially the consumer of health care, either healthy or as a patient, is coming more and more into the focus; for example he or she uses personalized information systems and, at the same time, receives personalized medicine. This only works if also social and ethical aspects are carefully taken into account. It is exactly this complexity and variety as well as the rapid progress in medicine and technology which make medical informatics so appealing as a scientific discipline.

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References