

Institute of Medical Informatics, Biometry, and Epidemiology

Chair of Medical Informatics

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Research focus

- Process support through health information systems
- Medical ontologies and medical knowledge processing
- Evaluation of health information systems
- Analysis, assessment, and visualization of medical data
- IT-infrastructure applications for medical research
- Translational cancer research

Structure of the Chair

Professorship: 1

Personnel: 19

- Doctor (of Medicine): 1
- Scientists: 14 (thereof funded externally: 11)
- Graduate students: 8

Research

Various working groups are concerned with the development and the introduction of electronic medical records, the integration of clinical decision support functions into hospital information systems (HIS), the modelling and optimization of clinical workflows, both data warehouse and data mining applications, the evaluation of the effect of health technology interventions on processes and persons involved in the health system, the use of mobile technologies in medicine and the development of IT infrastructures for research and teaching. The integration of clinical and research data within hospitals and data sharing within large networks, e.g. in the context of the German Medical Informatics Initiative and the German Biobank Alliance, are a particular focus of our research activities.

Prof. Dr. H.-U. Prokosch is as Chief Information Officer also responsible for the strategic development of information processing at UK Erlangen.

Process support through health information systems

One of the major challenges in the design, establishment, and management of health information systems (HIS) is the intersectoral interoperability which is important to optimize the cooperation of the various health service providers across institutional boundaries in outpatient and inpatient care in order to deliver the best patient care. For an additional reduction of patient risks, we integrate clinical decision support functionalities into HIS. Clinical information flow and communication functionalities should ultimately involve and benefit patients, e.g. by the application of medication plans or by the use of a personal electronic health record. In addition to grant funded projects, the Chair also pursues and supports several innovative pilot projects embedded in the SOARIAN® HIS environment of UK Erlangen (e.g. a complete clinical cancer documentation embedded in a comprehensive clinical data reuse concept). The direct integration of the patient by means of an online-based capturing of follow-up information and the idea of a patient portal which is integrated into HIS and its IHE (Integrating the Healthcare Enterprise)-based integration with a patient's personal electronic health record complete the range of research on this focus.

Medical ontologies and medical knowledge processing

In our projects, providing knowledge processing systems in medicine always comprises knowledge modeling and the implementation of standardized knowledge modules for example to support drug therapy and drug prescription or to reduce patient risks within intensive care units (ICU). Within the patient data management system of an ICU, a clinical decision support system has been integrated to monitor the exceedance of threshold values or to monitor critical trends of various laboratory values and, as a consequence, to have a direct feedback sent as a text message to the DECT telephone of the clinician on duty. Further use cases comprise the automated patient-individual monitoring of the expiratory tidal volume to avoid lung injury in patients under mechanical ventilation as well as the implementation of cross-patient dashboards and their integration into the existing computer system with a parallel evaluation and optimization of their usability. In a second project we have initiated a user centered design process for the development of a computer-based guideline to support intraoperative emergency situations. Against this back-

ground, we are concerned with all aspects of the use of software as a medicinal product.

Evaluation of health information systems

When introducing new information technologies, it is essential to evaluate their effect on user satisfaction, work processes, and process costs to avoid adverse effects of these technologies on medical care. Successful use of IT in medicine may be hindered by negative user attitudes, user-unfriendly interfaces, and insufficient usability in general. In numerous evaluation studies, we have applied methods, such as usability questionnaires, observations, thinking aloud, and cognitive walkthrough, to both optimize and evaluate the acceptance of different kinds of IT artefacts. In cooperation with the Department of Anesthesiology, as well as further German anesthesiologists and the foundation German anesthesiology ("Stiftung Deutsche Anästhesiologie") we perform usability analysis of different levels of prototypes and mockups for a computerized emergency checklist. Further, we cooperate with the Department of Pediatrics and Adolescent Medicine in the stepwise development and usability analysis of a web-based medication information system to support drug therapy for children. Moreover, in the context of different master theses a tool for calculating percentiles and an Arden dashboard have been evaluated for the Department of Pediatric and Adolescent Medicine and the interdisciplinary operative ICU of UK Erlangen, respectively, in terms of their efficacy and efficiency in clinical routine.

Analysis, assessment, and visualization of medical data

An increasing amount of data is documented electronically in clinical IT systems during routine patient care. To avoid information overload or overlooking of essential facts, appropriate and flexible visualization methods are required. We have been creating a learning health system by reusing such data for research projects. In cooperation with Harvard University Medical Center, the i2b2 (informatics for integrating biology and the bedside) platform has been integrated with UK Erlangen Clinical Data Warehouse and enhanced with semantic ontology annotations as well as timeline-based visualization methods. It has been established as a research integration platform for several projects at UK Erlangen, but also within national collaborations. The project "Klinische Datenintelligenz" (clinical data intelligence) aims at integrating both structured and

free-text data as well as images and genomic data for research. Complex algorithms are processed on the basis of Big Data technologies (e.g. Hadoop) and can be analyzed in interactive applications (e.g. tranSMART). Furthermore, we have provided the tranSMART platform for different research groups at our Faculty for the purpose of integrating genomic data into clinical data. In this context the Chair is evaluating both the use and the usability of the platform for its application in the fields of cohort identification and data exploration. In the MIRACUM consortium (Medical Informatics in Research and Care in University Medicine; compare own report), we evaluate and enhance the translational platform cBioPortal (originally developed at the Memorial Sloan Kettering Cancer Center, New York, USA), which aims at integrating and visualizing clinical findings and genomic analysis data. The final goal is to thus provide an optimized information presentation for enhanced IT supported therapy decisions in molecular tumor boards.

IT-infrastructure applications for medical research

Today, medical research is often pursued within networked multi center structures, which require efficient and safe IT-infrastructures. The Chair has designed and provided such web-based electronic data capture systems for many medical multicenter research projects, such as the Polyprobe Study, the nation-wide registry for chronic kidney diseases (GCKD), and the CONKO-007 study on radiochemotherapy for pancreatic cancer. Moreover, current activities comprise IT infrastructures to support biobanking especially the national (German Biobank Node, German Biobank Alliance) and international (BBMRI Common Service IT/ADOPT) linkage of biobanking. A further focus was laid on the single-source reuse of patient data for clinical and translational research. The Chair is member and active partner in many projects and working groups of the TMF (German technology and methods platform for networked medical research) and leads the GMDS working group "Reusing electronic patient records for clinical research". We lead the MIRACUM consortium, in which we currently design, develop, and implement an ecosystem of open source software tools (MIRACOLIX: e.g. ID-management, consent-management, federated authentication, several research data repositories, long term archiving for research data), which form the building blocks for the establishment of data integration centers at each of the university hospitals.

Translational cancer research

A special research focus for the reuse of clinical data in research as well as for quality management purposes is the efficient IT support in the context of cancer care and translational cancer research. We have designed and established a comprehensive single source framework of IT components supporting tissue banking, multicenter cancer trials, cancer registration, and routine cancer care documentation. While interfacing the new cancer registry database of UK Erlangen's Comprehensive Cancer Center (CCC; compare own report) with our EHR system, we designed a reference model for cancer documentation comprising a set of elementary documentation packages, related processes within patient care, quality assurance and research, respective information systems as well as interfaces to be established. A further aspect of research in this field was the draft and the establishment of a study registry for CCC, which provides the basis for all study-related analyses and reports, for the official listing of studies on the CCC homepage, and, at the same time, for the study assignment within HIS 'Soarian Clinicals' for the patients of UK Erlangen.

Teaching

The Chair of Medical Informatics is involved in the education of students of Medicine, in the degree programs of informatics (minor subject: medical informatics) of the Faculty of Engineering as well as in the interdisciplinary degree program Medical Process Management and in the cross-faculty courses of the degree programs in medical engineering. In all these courses, the innovative laboratory for medical informatics and eHealth which is an established feature at the Chair of Medical Informatics is used as the Erlangen laboratory of medical informatics ("EMIL") in the form of a Skills Lab and in the context of an innovative teaching concept.

Selected publications

Hinderer M, Boeker M, Wagner SA, Binder H, Ückert F, Neue S, Hülsemann JL, Neumaier M, Schade-Brittinger C, Acker T, Prokosch HU, Sedlmayr B. The experience of physicians in pharmacogenomic clinical decision support within eight German university hospitals. *Pharmacogenomics* 2017, 18,8: 773-785

Christoph J, Knell C, Bosserhoff A, Naschberger E, Stürzl M, Rübner M, Seuss H, Ruh M, Prokosch HU, Sedlmayr M. Usability and suitability of the Omics-integrating analysis platform tranSMART for translational research and education. *Appl Clin Inform.* 2017, 8,4: 1173-1183

Prokosch HU et al. MIRACUM: Medical Informatics in Research and Care in University Medicine. *Methods Inf Med.* 2018 Jul;57(S 01):e82-e91

Maier C, Lang H, Storf H, Vormstein P, Bieber R, Bernarding J, Herrmann T, Haverkamp C, Horki P, Laufer J, Berger F, Höning G, Fritsch HW, Schüttler J, Ganslandt T, Prokosch HU, Sedlmayr M. Towards implementation of OMOP in a German university hospital consortium. *Appl Clin Inform.* 2018 Jan;9(1):54-61

Kraus S, Toddenroth D, Prokosch HU, Bürkle T. Using Arden Syntax Medical Logic Modules to reduce overutilization of laboratory tests for detection of bacterial infections – success or failure? *Artif Intell Med.* 2018 Nov;92:43-50

Sedlmayr B, Schöffler J, Prokosch HU, Sedlmayr M. User-centered design of a mobile medication management. *Informatics for health and social care. Inform Health Soc Care.* 2018 Mar 5:1-12

International cooperations

Prof. Dr. E. Ammenwerth, Private Universität für Medizinische Informatik und Technik (UMIT), Innsbruck: Austria

Prof. Dr. T. Bürkle, Berner Fachhochschule, Biel: Switzerland

Prof. Dr. I. Kohane, National Center for Biomedical Computing, Boston: USA

Prof. Dr. C. Sawyers, Dr. A. Zehir, Memorial Sloan Kettering Cancer Center, New York: USA