The Future of Medical Informatics

Some Perspectives of Intra- and Inter-institutional Information Systems

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Keywords
Health information systems, hospital information systems, information management, IT service management, architectural models, quality, strategic plans, ITIL, COBIT, SOA

Summary
Objectives: Presenting the author's point of view on chances and challenges of medical informatics in research, education, and practice of information management, especially in the field of regional as well as institutional health information systems.
Method: Collecting and interpreting current issues concerning (health) information systems and their management from selected references.
Results: There are challenging research topics concerning information management, IT service management in small health care units, reference models, trustworthy architectures, service-oriented architectures. Medical informatics requires multidisciplinarity.
Conclusions: Medicine and health care need medical informatics as a scientific, researching discipline.

Methods Inf Med 2009; 48: 62–65
doi: 10.3414/ME9138
prepublished:

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1. Introduction

Since a large variety of software for information systems in healthcare is already available on the market, the necessity of research and academic education in the field of health information systems (HIS) may be called into question. German academic medical centers have also been dealing with this question and, as a result, medical informatics departments were closed at three universities within the last two years, Of course, this did not meet enthusiastic approval on the part of medical informatics professionals both in practice and in research and education.

Medical informatics is certainly not an end in itself but must be considered as an effective support for health care and medical research. Therefore, we should give convincing answers to the following question:

- What kind of contributions of medical informatics as a scientific discipline are necessary within the next years in order to keep intra- and interinstitutional information systems in health care and medical research as efficient as necessary?

Based on a thorough discussion on medical informatics as being art, science or even a separate scientific discipline [1–4] a vision of medical informatics has been developed in a series of publications [5–8] within the last years. Far from adding a new vision, this paper shall give answers to this question by outlining some particular current trends and issues discussed in medicine and in the fields of information systems, health information systems and information management. New challenges to medical informatics as a scientific discipline and their contributions to solving problems shall be derived from these issues discussed.

2. Trends in Medicine, Information Systems and Information Management

2.1 Trends in Medicine and Health Care

Medicine and health care turn out to be increasingly driving economic factors worldwide [6, 9] with information and communication technology being one of their most important resources [10]. Thus, there is a special need for effective and efficient information systems. However, these information systems have to be adjusted continually to the changing demands stemming from trends in medicine and health care such as:

- Patient-centered medicine and "continuity of care" [11] require information systems that are not designed for institutions but for patients [4]. Thus, medical informatics does not only have to expand "the scope of health information systems – from hospitals to regional networks, to national infrastructures, and beyond" [12]. Moreover, patients have to be empowered to take part in controlling their own health records [13, 14]. Additionally, information systems have to be integrated with electronic devices (including entertaining devices) at patients' homes [15] and have to support various telemedical services [16].
- Quality assurance as well as economic pressure call for access to and support by current medical knowledge. Hence, there is a need for information systems offering guidance through evidence-based clinical pathways [17–19].
- Evidence-based medicine needs clinical research, and this is the reason why information systems have to provide a "two-

way road" between bedside (patient care) and bench (clinical research) to make clinical data available e.g. in clinical trials [20, 21]. But this two-way road has to be expanded to a triangle covering the integration of genetics and bedside as well [22].

- Stress of competition among health care providers will increase. This is not only due to the current political discussions on financing national health care systems but also to the increasing importance of "health care consumers" to be clients in a market of "consumer health"[4, 9, 23]. Hence, there is a need for a more efficient support of information systems regarding financial control as well as product planning and production control in health care.
- Molecular diagnostics will enable more appropriate selection and even individual design of therapies, e.g. drugs, and so there is a need for information systems being able to handle large amounts of molecular data. As there is an increasing demand for computer assistance in operating theaters [24, 25], information systems are required that are able to additionally process large amounts of image data in real time.

2.2 Trends in Information Systems

Complex, heterogeneous and even nation- or worldwide information systems are not a unique issue in medicine and health care but inherent to other industries as well. Hence, we have to take into account related trends and issues discussed in that field. Let us consider especially SOA (service-oriented architectures) [26] and "Green IT" [27]:

- As soon as in 1984 it had been promised that "the construction of monolithic systems is now declining" ([28], p. 225). After recent trends of object-oriented programming [29] and component-based architectures [30–32] SOA is another promising approach to overcome information systems dominated by software of a single vendor and to support "best of breed" architectures [30, 33]. Even an ERP (enterprise resource planning) and HIS software vendor like SAP is promoting this technology [34]. Although SOA provides new chances for adapting HIS to the needs in medicine [35–37], there are still problems like defining services appropriately [37, 38] and managing complex service integration tools [39].
- Despite "Green IT" seems to be a commercial buzzword at current fairs [40] and far from interest of academic medical informatics, it has a considerable impact on medicine and health care. If we are supposed to design a modern information system including electronic patient records for a large academic medical center such as the Leipzig University Medical Center (LUMC), we may need approx. 4000 PCs and two redundant computing centers. If we assume a power consumption of approx. 300 watt for each PC the total consumption will be approx. 1.2 MW (megawatt) for the PCs. At LUMC 0.5 MW for the computing centers have to be added. Altogether, this would be more than enough power to heat 170 detached houses even in coldest winter times. It would be quite easy to calculate the considerable amount of annual costs resulting from the related energy consumption. These numbers emphasize the need for close collaboration of information management departments and facility management and technical departments in a hospital in order to find solutions for energy recycling e.g. to support hot water supply. Hence, medical informatics or, more precisely, information management in health care has to be considered much more as an integral as well as integrating part of hospital-wide management.

2.3 Trends in Information Management

There has been only little research on information management in the sense of management of information systems in medical informatics up to now. In Germany, an interdisciplinary working group published a proposal for classifying information management tasks in hospitals some years ago [41]. This approach proved to be helpful but not sufficient, especially for detailed organizing structures, services and processes in information management departments of health care institutions. Well-established approaches from other industries like CobiT and ITIL are now under deeper consideration in medicine and health care:

- CobiT (Control Objectives for Information and Related Technology) is a framework for structures and processes supporting the alignment of information systems and enterprise strategy (strategic alignment) [42]. Especially the suggested key performance indicators have the potential of efficiently supporting the control of information systems in health care.
- The IT Infrastructure Library (ITIL) is a systematic collection of best practice solutions for structuring tasks and processes for the design and delivery of services in information management [43–47]. ITIL obviously provides considerable chances for better service delivery by information management departments in hospitals. However, due to its complexity (see the number of books cited before) small and medium-sized hospitals will hardly have the chance to implement the framework without efficient support. Up to now, no reports on experiences in using this framework at medical settings were found in Pubmed.
- ITIL's main goal is high-quality service delivery. This does not only hold for the delivery of services to external customers, but also to customers within the same institution like a hospital. Especially medical departments in hospitals do not only expect lower-level IT services like print or data storage services, but also high-level or so-called business services like a radiologic imaging service [48]. However, there are no catalogues of such services available and it seems unlikely that especially IT departments of smaller hospitals will be able to define their business service portfolio from scratch. Additionally, such portfolios have to integrate service level agreements (SLA), i.e. verifiable descriptions of service quality.
- ITIL provides many processes for IT departments to organize service delivery. These processes need to be integrated with processes for strategic information management (e.g. developing strategic IT plans) and project management as a part of tactical information management [41, 49]. Integrated Information Management Information Systems (IMIS) are necessary

to support these processes in the same way as health information systems do with care processes. Especially components for strategic planning, monitoring strategic plans, configuration management [43] and project management have to be well integrated.
- Up to now, concepts for organizing information management have been designed for single institutions. However, future medical care will be organized within networks of care providers. The problem of information management of these networked regional health information systems has still to be solved [50].

3. Contributions of Medical Informatics as a Scientific Discipline

A lot of research and development topics can be derived from the challenges mentioned before. Some of them shall be outlined here:
- Information management in health care has to be better integrated not only with enterprise management but also with facility management in order to optimize energy consumption at enterprise level, for example. New concepts are necessary to overcome the detachment of information and facility management. Those concepts can only be developed in close cooperation of both medical informatics and business administration experts.
- Health care provided by regional networks needs reliable and trustworthy regional HIS. Reliability and trustworthiness, on the one hand, depend on the information systems' architecture. New methods for model-based design of even large, complex and regional information systems' architectures should be developed. Metrics and key performance indicators supporting quality measurement of information systems have to be integrated.
- On the other hand, reliability and trustworthiness depend on the information systems' management as well. Since members of regional care networks are – at least in Germany – quite independent, new concepts for cooperated management of the underlying information system have to be developed. Again, experts from the field of business administration need to be involved in those research activities.
- SOA offers new chances for integrating clinical trials and their documentation tools into hospital information systems. Related services should be integrated into an overall catalog of services to be provided by information systems' modules in health care. Former component-based concepts [51] like HISA [35, 52] and CORBAmed [53] can be reused.
- A light and medical version of ITIL should be developed taking into account the very small IT departments of small hospitals as well as the before mentioned services to be provided in health care. Concepts and criteria are required, distinguishing services provided by IT departments from those provided by components of information systems. Additionally, organizational specialties from the medical sector, like the position of Chief Medical Information Officers (CMIO) [54, 55], have to be integrated.
- A light and medical version of CobiT should be developed which especially provides key performance indicators well-suited and adopted to health care settings.
- Reference models for 'information management information systems' (IMIS) integrating strategic, tactical, and configuration management as well as the management of IT service management should be developed.

4. Conclusion and Discussion

The aim of this paper was to stimulate the discussion on perspectives of medical informatics. For this purpose it provides a selection of topics. Even the small range of topics discussed in this paper can highlight chances and challenges in the field of medical informatics:
- We as medical informatics professionals are used to collaborating interdisciplinary, especially with doctors and medical researchers. However, we also have to intensify our collaboration with (software) engineers, lawyers, business administrators and so on. Even environmental issues are part of the responsibility of medical informatics in research and practice. All these aspects have to be considerable parts of education in this field.
- There is no doubt, that – even in the small range of topics mentioned – there are lots of exciting research topics to deal with now and in the future. Medical informatics will surely play an essential role in medicine to continue delivering high-quality care efficiently to people worldwide.

This paper neither claims for completeness nor suggests focusing medical informatics on the few topics presented here. On the contrary, medical informatics needs to maintain and further develop its broad view on problems of information processing in medicine. On this basis, medical informatics will have a future with exciting perspectives concerning intra- and inter-institutional information systems and beyond.

Acknowledgment

Thanks to Mrs. Roeder for improving the readability of the paper.

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