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Visions and strategies to improve evaluation of health information systems Reflections and lessons based on the HIS-EVAL workshop in Innsbruck

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Summary *Background:* Health care is entering the Information Society. It is evident that the use of modern information and communication technology offers tremendous opportunities to improve health care. However, there are also hazards associated with information technology in health care. Evaluation is a means to assess the quality, value, effects and impacts of information technology and applications in the health care environment, to improve health information applications and to enable the emergence of an evidence-based health informatics profession and practice. *Objective:* In order to identify and address the frequent problems of getting evaluation understood and recognised, to promote transdisciplinary exchange within evaluation research, and to promote European cooperation, the Exploratory Workshop on ''New Approaches to the Systematic Evaluation of Health Information Systems'' (HIS-EVAL) was organized by the University for Health Sciences, Medical Informatics and Technology (UMIT), Innsbruck, Austria, in April 2003 with sponsorship from the European Science Foundation (ESF). *Methods:* The overall program was structured in three main parts: (a) discussion of problems and barriers to evaluation; (b) defining our visions and strategies with regard to evaluation of health information systems; and (c) organizing short-term and long-term activities to reach those visions and strategies. *Results:* The workshop participants agreed on the Declaration of

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Innsbruck (see Appendix B), comprising four observations and 12 recommendations with regard to evaluation of health information systems. Future activities comprise European networking as well as the development of guidelines and standards for evaluation studies. *Conclusion:* The HIS-EVAL workshop was intended to be the starting point for setting up a network of European scientists working on evaluation of health information systems, to obtain synergy effects by combining the research traditions from different evaluation fields, leading to a new dimension and collaboration on further research on information systems' evaluation.

1. Introduction

Nowadays, it is hard to imagine health care without Information and Communication Technology (ICT). Information technology in health care has existed for about three decades, and has gained widespread usage. Electronic patient records offer health care professionals access to vast amounts of patient-related information; decision support systems support clinical actions; and knowledge servers allow direct access to state-of-the-art clinical knowledge to support evidence-based medical practice. Communication technology has provided standardized healthcare-related communication protocols, which enable exchange of all kinds of information among health care parties. Networked health care environments are being developed in which regional health information systems support seamless care and thus enable provision of and access to health services and health-related information across organizational, regional and national boundaries. Health care is indeed entering the Information Society [1,2].

The term ICT refers to technologies as such. Whether the use of these technologies is successful depends not only on the quality of the technological artifacts but also on the actors, i.e. the people involved in information processing and the organizational environment in which they are employed. ICT embedded in the environment, including the actors, is often referred to as an Information System (IS) in a sociotechnical sense [3].

Introduction of ICT can radically affect health care organization and health care delivery and outcome. It is evident that the use of modern ICT offers tremendous opportunities to support health care professionals and to increase the efficiency, effectiveness and appropriateness of care [4,5]. However, there can also be hazards associated with information technology in health care. ICT can be inappropriately specified, have functional errors, be unreliable, user-unfriendly, ill-functioning or the environment may not be properly prepared to accommodate the ICT in the working processes (compare, e.g. [6—8]). Such breakdowns and failures may negatively affect the working processes and decisions of health care providers and may result in harm for the patients, i.e. ICT can create adverse side effects in the care process [9]. Good medical practice implies that one is aware of the possible side effects of one's actions and that one has insight into the implication of such side effects. Similarly, there is a need for evaluation of ICT systems that are (intended to be) in operation in a health care environment to identify potential side effects. Such evaluations should not only be carried out during operation (summative evaluation)—like in post-marketing surveillance of drugs—but also during system development (constructive, formative evaluation during system analysis, design, and implementation) as to avoid the potential misalignment of the intended system and the system actually being developed as well as to identify harmful consequences as early as possible.'Evaluation' is often defined as the act of measuring quality characteristics of an object. However, those measures have no value in themselves—they need a context within which they are judged or used: there has to be a question to be answered. We, therefore, prefer to use the concept of 'evaluation' in the following sense:

> Evaluation is the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context.

1.1. Evaluation questions

Typical evaluation questions are, for example (cp. also [10]):

- Is the technology usable in the intended environment and for the intended user group and task? Do the different user groups (e.g. physicians, nurses, and administrative staff) accept the ICT and use it as intended? What are the patterns in

the users' attitude towards the (future) system, and their pattern of behaviour? Have the users had sufficient training and guidance to be able to use the technology appropriately?

- How does the technology affect structural or process quality (e.g. time saving, data quality, clinical workflow)? What are the effects of an information system on the quality of patient care (outcome quality)? To what extent does the information system meet not only the requirements but also the objectives? What are the reasons for the observed effects?
- What are the investment and operational costs of ICT-based solutions? Are they cost-effective? What is their return on investment?
- What are the problem areas of an information system in daily operation? What are current pitfalls with it, and how can it be improved?
- What are the organizational and social consequences of introducing ICT into health care environments and how can we include these aspects into design, development and installation to achieve the planned changes in the working structures, work content and work environments?

1.2. Barriers to evaluation

The necessity, but also the complexity, of evaluation studies has been discussed in the literature for some years now (compare, e.g. [11—16]). Reasons for problems encountered during evaluation studies were identified as follows:

- Insufficiently available evaluation methods, guidelines and toolkits to cope with the complexity of health care information systems originating from a combination of technical as well as organizational and social issues.
- Insufficient collaboration between evaluation researchers from different academic fields and traditions.
- Little support by methods and guidelines for constructive (formative) evaluation in an implementation or installation project, since many studies focus on summative aspects.
- Often insufficient and costly evaluation studies are carried out, which do not ask or are not able to answer the important questions of information systems evaluation.
- Limited value of evaluation reports to others, because these lack sufficient information enabling others to adopt the approach or to judge the validity of the conclusions given.

Additionally, the innate organizational resistance to evaluation has been identified as a barrier for doing evaluation studies [17]. Reasons include the diversion of resources from activities that are perceived as more creative, the reluctance to find and publicize ''failures'' or ''mistakes'', and concern about encouraging damage-seeking litigation. To counterbalance this, better publicity of evaluation approaches, but above all of the proven benefits of evaluation and adoption of lessons learned, are needed.

1.3. Earlier work

There have been some earlier initiatives to address these problems.

- SYDPOL comprised a number of Nordic collaborative projects under the Nordic Council of Ministers. Its Working Group 5 (1986—1989) focussed on computer-based decision support for clinical work within health care, resulting in guidelines for user evaluation of medical decision support systems [18,19].
- In 1989 a workshop was organized around ''System Engineering in Medicine'', sponsored by European commission under the Medical and Health Research Programme (COMAC-BME). One topic of that workshop was devoted to evaluation of decision support systems [20]. One of the conclusions was that there was a need for further development of methods for evaluation. This topic was further elaborated in the accompanying measure under the COMAC-BME programme. The SYDPOL report was one of the input sources for the work of this group. Although no final conclusions have been published, papers by Wyatt and Spiegelhalter reflect some of the topics discussed during that time [21,22].
- ASSIST was an EU fourth Framework project (1989—1990) with the purpose of developing a framework for assessment of medical applications. The framework was focussed on identifying important dimensions, issues and criteria for assessment rather than on developing guidelines or methodologies for assessment (unfortunately, there is no publicly available material on this work).
- A working conference on the topic ''Assessment of Medical Informatics Technology'' was held in Montpellier [23] as early as 1990 with the aim to (1) ''develop a dialogue between the fields of medical informatics and Health Technology Assessment in order to share current states of progress and to build an agenda for future work and collaboration''; and (2) ''to

issuing recommendations about the methodological requirements for evaluating Health Information Systems''. Their recommendations are among others (i) the need to clarify and define a terminology; (ii) the identification of possible techniques and methods; (iii) the urge for constructive assessment in a life-cycle perspective; (iv) the emphasis shall go far beyond that of the technology alone and include the aspects also addressed in Health Technology Assessment (HTA); (v) inter-disciplinarity with (inter)national cooperation and exchange of data; (vi) enhancing the ideology of health care assessment in all respects by promotion, dissemination and education. A concrete result of this meeting was the establishment of the IMIA working group on Technology Assessment and Quality Development.

- A number of assessment activities have taken place in the AIM (Advanced Informatics in Medicine) programme of the EU. The concerted action ATIM (Assessment of information technology in medicine, 1993—1994) aimed at making an inventory of approaches towards evaluation methodologies. ATIM mainly considered two types of applications: (1) knowledge-based systems; and (2) imaging systems and clinical workstations. ATIM gathered methodological approaches and experiences from the other AIM projects such as KAVAS-II, EURODIABETA, TELEGASTRO, ISAR, COVIRA, SAMMIE, EurIpacs and MILORD, the result of which is published as a number of individual contributions in [24].

- An ESPRIT Project, Megataq, running under the EU fifth Framework Programme (http://www.megataq.mcg.gla.ac.uk/information.html), had as its topic evaluation of IT systems, however focused on CSCW systems (computer supported cooperative work) and usability aspects. One of the team's obligations was to make a list of assessment studies published in the literature, yet they delimited themselves to the field of informatics (information technology, computer science) and consequently missed the opportunity to harvest the experiences in application-oriented domains like medical informatics. Unfortunately, their website has been inactive since mid 2002.

- The VATAM Project (validation of telematics applications in medicine; http://www-vatam.unimaas.nl) was launched 1996 based on the results of other EU funded projects (primarily ATIM) as an accompanying measure on criteria and methods for the validation of projects with emphasis on health care. The purpose of VATAM was to take stock of validation of health care telematics applications in EU research projects with the objective to enhance them. The initiative made recommendations to improve validation and provided guidelines describing the main steps of evaluation [25]. The goal to provide a list of usable tools was less successful, but formed the basis for more recent work.

- In addition to this work several books address the issue of evaluation of IS and ICT, e.g. [26—28] (an annotated bibliography is available at http://www.umit.at/efmi/bibliography.htm).

Also the IMIA working groups on Organizational and Social Issues and on Technology Assessment and Quality Improvement recognized the need for assembling and disseminating of knowledge and experience on evaluation of ICT in health care. This resulted in a workshop in Helsinki in 1998, the proceedings of which have been published in a special issue of the International Journal of Medical Informatics [29].

Networking initiatives such as the Working Group for Assessment of Health Information Systems of the European Federation for Medical Informatics (EFMI WG EVAL, http://www.umit.at/efmi) and the Working Group Technology Assessment and Quality Improvement of the International Medical Informatics Association (IMIA WG TA, http://www.imia.org) try to support interdisciplinary information exchange, e.g. by organizing workshops and tutorials at medical informatics conferences or by offering a database of assessment publications. However, the voluntary basis of those initiatives limits their impact.

1.4. The need for further impetus

Overall, the problems seem clear; however, the solutions still are not satisfying. The recommendations given in the Montpellier meeting seem still to be valid today. Why is it that so little progress seems to have happened over more than a decade? One important aspect making progress so difficult seems to be the transdisciplinarity of evaluation theory and practice, meaning to combine and adapt methods and approaches from various disciplines to best solve the problem at hand, needing a combined expertise, e.g. from medical informatics, computer science, biostatistics, psychology, social sciences and health economics [30].

Each research tradition has its unique set of methods, tools and guidelines, enabling it to answer specific evaluation questions. Progress has been made, but the awareness that other domains have to be taken into account is not yet widespread in the medical informatics community. A transdisciplinary discussion, in order to promote evaluation

research, is still at the beginning. A second factor making progress difficult is the lack of strong published evidence of the benefits gained from investing skills and resources into evaluation studies, either into individual studies or into the development of methodologies. A third reason seems to be the resistance of decision makers and health IT system proponents to the idea of ''mistakes'' being identified and highlighted [9].

1.5. The HIS-EVAL initiative

In order to promote transdisciplinary collaboration within evaluation research and evaluation practice, an Exploratory Workshop on ''New Approaches to the Systematic Evaluation of Health Information Systems'' (HIS-EVAL) was organized by the University for Health Sciences, Medical Informatics and Technology (UMIT) in Innsbruck, Austria. It took place from 4 to 6 April 2003 and was funded by the European Science Foundation (ESF).

The objectives of the workshop were:

- to bring together experts from computer science, medical or health informatics, economics, health care, health care management, biostatistics, psychology, sociology, and other disciplines, in order to foster a dialogue and exchange on methodological issues between researchers from different traditions;
- to offer an opportunity for the participating scientists to share their knowledge with the aim of obtaining a profitable cross-fertilization among different fields of expertise and especially between quantitative and qualitative evaluation research;
- to initiate a combined research agenda to develop guidelines and toolkits for information systems' evaluation for an adequate use and combination of evaluation methods and tools;
- to discuss and clarify the networking needs in long-term evaluation research in medical informatics, and to initiate combined research activities at a European level.

In total, 23 researchers from 10 European countries participated in the workshop (see Appendix A).

2. Methods

The HIS-EVAL workshop was organized alternately around plenary discussion sessions and smaller working groups. The outcome of the plenary discussion was used to refine or make concrete tasks for the succeeding working group sessions.

The overall program was structured along three major questions:

1. What are problems and barriers to evaluation of health information systems? In this first part, the experiences from the various evaluation fields were gathered and structured. The different viewpoints of the participants were discussed, as well as the value of what evaluation researchers from the different traditions have to offer, and how they can contribute to evaluation studies.
2. What are our visions and strategies with regard to evaluation of health information systems? This part comprised discussions on what the participants wanted to achieve in the next years in the field of evaluation. The discussion was structured around methods and practice of evaluation.
3. What could be short-term and long-term activities to reach those visions and strategies? In this last part, concrete activities were planned to promote theory and practice of evaluation. Discussion was organized in three different task groups, focussing on (a) the establishment of an evaluation portal, (b) guidelines for evaluation studies and evaluation reporting, and (c) communication and dissemination.

The workshop ended with a discussion on a common time schedule for combined activities within the next 1—2 years.

3. Results

The main points of discussion are shortly summarized below. A detailed protocol of the workshop is available at http://bisg.umit.at/hiseval. The following summary is structured according to the three main parts of the workshop.

3.1. Part 1: Problems and barriers

The following main problems and barriers were identified with regard to the evaluation of health information systems:

- *Awareness*: Evaluation is often seen as too academic, and the value of evaluation studies (e.g. the contribution to improved decision-making, identification of implementation barriers, support of development, implementation or procurement of technology or influencing user's expectations) is often not sufficiently clear to the technical developers, decisions-makers, users, and politicians. The contribution of evaluation is

not valued. When evaluation is done, it can be sometimes more a 'fig leaf' than a contribution to reflective practice. Managers do not ask for evaluations because either they do not want their decisions evaluated or they do not see the value of the evaluation study for the decision they have to make. Consequently, conducting evaluation studies seldom brings rewards to evaluators.

- *Methodological issues*: Case studies on evaluation are often not sufficiently grounded in theory, and established evaluation methods are frequently poorly applied. Evaluators are often insufficiently trained to select methods from various disciplines and to apply and combine these adequately. The proper design of evaluation studies, the selection of a framework to be applied and of methods to be used is difficult. The complexity of an application and its speed of change seem to make adherence to a rigid methodology difficult. Various evaluation traditions (e.g. the positivist versus the constructivist traditions) do not sufficiently collaborate to cross borders, and a common language for evaluation is missing.

- *Practical issues*: Evaluators and evaluation sponsors may have vested and conflicting interests. Therefore, it may be difficult to formulate clear and answerable evaluation questions. When the target audience of an evaluation study is not sufficiently clear, the resulting reports may be collecting dust on a shelf. In addition, guidelines for good evaluation practice are missing, as well as registries of ongoing studies, evaluation methods and tools. Further, it is unclear how evaluation results originating from local studies may generate knowledge that is of value for others. Moreover, as the benefits of evaluation studies are less recognized, funding for evaluation is usually insufficient. Finally, evaluation studies are often not carried out during the entire life cycle, but only after the event, the installation.

- *Dissemination*: Evaluation results (especially if the study failed to find benefits) and reports are often not published. Proven evaluation methods are not easily found in the literature and dissemination of existing knowledge by means of technical (scientific) reports from evaluation studies is compromised as these documents are seldom referenced. Hence others are not aware of and do not have access to this source of valuable information.

3.2. Part 2: Visions and strategies

The visions and strategies for the future of evaluation research can be structured around similar topics, and envision the following scenarios the participants wanted to reach in the near future:

- *Awareness visions*: Evaluation is considered as of high intellectual, organizational and societal value. Researchers get sufficient reward for performing good evaluation studies, and the duality of evaluation (supporting research as well as generating information, knowledge and insight for local decision-making) is recognized and appropriately balanced. Evaluators have better knowledge of available evaluation methods, and are aware of evaluation methods from other disciplines. Evaluation results are used to contribute to clinical or managerial decisions and actions, to health policy decisions, and to improved design and development of health information systems. Measurement of success and non-success is an integral part of IS design, development, implementation and operation.

- *Methodological visions*: Development and combination of evaluation methods is considered as a worthwhile scientific endeavor. Methods and methodologies are solidly grounded on theory and validated through scientifically sound research. Methods are chosen solely based on the study questions rather than on the research paradigm. The methods appropriately take into account the complexity of health care as well as new paradigms in health care (e.g. disease management etc.). Continuous education opportunities for evaluators are offered and broadly used.

- *Practical visions*: Sufficient funding for continuous and constructive evaluation is available. National Centres of Excellence in Evaluation are founded. They form a network to strengthen the knowledge base on evaluation. Evaluation is an integral part of all projects where ICT is planned, developed, purchased or installed into health care organizations to form health IS's. Central registries of guidelines and evaluation methods, and a database of ongoing evaluation studies support evaluation practice. Multi-professional and independent committees guarantee the quality of evaluation study plans. Evaluators are independent and shielded from legal actions. A common terminology for evaluation exists, and evaluators from multiple disciplines cooperate closely. A Cochrane-like database for IS evaluation is established. A list of publications on benefits and adverse effects of ICT is available.

- *Dissemination visions*: Evaluation results are published for various audiences, to make information and knowledge available. Papers on evaluation studies as well as on evaluation research are widely published, both in specific evaluation

journals as well as in broader healthcare and medical informatics journals. The quality of reporting evaluation studies is improved by standards, and so is the quality of the evaluation studies in themselves by means of guidelines for good evaluation practice.

3.3. Part 3: Implementation activities

The participants agreed on the following activities that should be pursued to reach the vision outlined above:

- *Evaluation portal*: Establishment of a web-based evaluation portal which supports evaluators by offering a methods repository, project reports, ongoing studies, validated instruments, evaluation guidelines, general literature, a glossary, a description of pitfalls & perils, and educational material.
- *Good evaluation practice*: Development of guidelines for good evaluation practice, including guidelines for dissemination of evaluation results and definition of standards for evaluation.
- *Good evaluation reporting*: Development of guidelines on how to report IS evaluation studies (comparable, e.g. to CONSORT statement [31]).
- *Organize network*: Establishment of a structured and funded network, establish a systematic review group on IS evaluation in health care, create a center of excellence for evaluation, promote transdisciplinarity of evaluation, organize workshops on evaluation, accumulate and share knowledge on evaluation theory and practice.
- *Create awareness*: Have evaluation accepted as a fundamental part of ICT development and introduction, create awareness for funding needs, improve publication possibilities, initiate funding agency for evaluation, and promote independence of evaluation studies.
- *Educate the evaluator*: Make transdisciplinary evaluation a topic of medical informatics curricula, provide continuous training opportunities for evaluators, develop online training material, and improve medical informatics professionals' understanding of available methods.

3.4. Immediate activities

Concrete activities, together with deadline and responsibilities, were then organized during the workshop for the first four topics. In general, it should be made clear to every stakeholder in healthcare settings that research on evaluation of ICT-based systems has the same importance as research on new methods or systems and their immediate implementation. The results of good evaluation studies deliver important information for healthcare decision-makers to establish or adapt their future ICT implementation strategy or even to revise existing deployment plans.

The activities concretely planned within the next 2 years are:

- Establishment of an Evaluation Portal in Health Informatics (EP-HI), which supports knowledge dissemination by being a comprehensive and continuously expanding source on validated evaluation methods/instruments, existing evaluation studies reports/publications, literature on evaluation and ongoing evaluation studies.
- Development of guidelines for Good Evaluation Practice in Health Informatics (GEP-HI), which provide guidance for planning and execution of evaluation studies.
- Development of Standards for Reporting Evaluations in Health Informatics (STARE-HI), which provide a structured framework for reporting of evaluation studies.

As a conclusion, the Declaration of Innsbruck was drafted during the meeting, presenting the major issues with regard to visions and recommendations for evaluation of health information systems. The final version of this declaration is presented in Appendix B.

Further activities will be organized under the umbrella of the Working Group on Assessment of Health Information Systems of the European Federation for Medical Informatics (EFMI WG EVAL, http://www.umit.at/efmi) in corporation with the IMIA Working Group on Technology Assessment and Quality Improvement. A joint European evaluation mailing list on evaluation has already been established (http://listman.umit.at/mailman/listinfo/eval).

4. Discussion

The HIS-EVAL workshop brought together experts in IS evaluation with various backgrounds and traditions to discuss theory and practice of evaluation of IS in health care. It was an initiative to build up an enduring evaluation research network for health information systems on a European level, with further activities such as research proposals, conferences, tutorials, workshops, and publication activities.

The Declaration of Innsbruck is a first important result. Many visions and possible activities are discussed in this declaration. Some of the activities

are already taking place, while others still have to start, established by enthusiastic and engaged researchers willing to spend efforts on the issues mentioned.

Both evaluation research and medical informatics are interdisciplinary fields in nature. Evaluation aspects are covered by various field-specific journals and conferences. To promote the transdisciplinarity of evaluation research, it seems necessary to have specific evaluation activities similar to the HIS-EVAL workshop, bringing together professionals from various disciplines. The objective of such workshops should be to create synergy between various evaluation paradigms, to further the development of evaluation methodology and methods, to promote theory and practice of evaluation of health information systems, to establish and maintain a network of experts in evaluation of IS in health care, and to reassess the research agenda for the field of evaluation of IS in health care.

Progress has been made since the working conference in Montpellier in 1991: The outcome of the HIS-EVAL workshop shows that a solid basis for good evaluation theory and practice already exists, yet needs to be promoted and published in a digested form. Terminologies have been gathered by more than one EU R&D project. Some of them have been published, but no efforts have been made to harmonize the various definitions. Constructive assessment is gaining more and more attention and thus experience with and methods for this approach are increasing. The dominating part of the literature is still focused on questionnaire-based studies, but reports with quantitative measures of effectiveness and efficiency, etc., as well as other qualitative measures are sporadically appearing in the literature.

We still need to increase the level of quality of the evaluation studies reported in the literature, as was substantiated in an objective analysis [14]. One step is to inform and create awareness in both the scientific medical informatics community as well as in health care in general on the value and needs for evaluation research and practice. The activities initiated at the HIS-EVAL workshop, i.e. development of an evaluation portal for information dissemination, development of reporting guidelines for evaluation studies, development of guidelines for good evaluation practice and organizing a network of evaluation researchers and practitioners are efforts to create such awareness and to provide the necessary foundation for good, future evaluation studies and study reports. With this contribution, we would also like to invite all stakeholders and interested parties to participate and play a role in this ongoing work.

Acknowledgements

Appendix A. Participants of the HIS-EVAL Workshop

This paper as well as the Declaration of Innsbruck was synthesized from the discussions at the HIS-EVAL workshop in Innsbruck in April 2003. The participants were (in alphabetic order):

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Appendix B. Declaration of Innsbruck

HIS€VAL

DECLARATION OF INNSBRUCK.

RESULTS FROM THE EUROPEAN SCIENCE FOUNDATION SPONSORED WORKSHOP ON
SYSTEMATIC EVALUATION OF HEALTH INFORMATION SYSTEMS (HIS-EVAL),
APRIL 4-6ᵀᴴ, 2003

Participants:

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DECLARATION

Health Information Systems are intended to improve the functioning of health professionals and organisations in managing health and delivering healthcare. Given the significance of this type of intervention, and the intended beneficial effect on patients and professionals, it is morally imperative to ensure that the optimum results are achieved, and any unanticipated outcomes identified. The necessary process is **evaluation**, and this should be considered an essential adjunct to design and implementation of information systems.

DEFINITIONS

§I.   A **system** is a set of components (e.g., actors and artifacts), together with their attributes and relationships, which as a whole is needed to accomplish an objective. A health information system (HIS) comprises actors (e.g., health care providers) and artifacts (the

information and communication technology - ICT - as well as the implemented algorithms and procedures) that together process health-related information in a health care organization. It operates in an organizational environment made up of people (e.g. system developers, politicians, managers, patients) and procedures, which influence its development and operation.

§II. **Evaluation** is the act of measuring or exploring properties of a health information system (in planning, in development, in implementation, or in operation), the result of which informs a decision to be made concerning that system in a specific context. Evaluation of health information systems has to deal with the actors, the artefacts, and their interaction to best support the decisions to be made.

OBSERVATIONS

(i) **Evaluation generates information to improve knowledge and to generate insight.** By doing this, evaluation of health information systems will ensure effective current health information systems, and contribute to better future ones. Since practicing medicine is an information intensive activity, a better health information system may also lead to an improved quality of care. This also implies that evaluation of ICT in health care only has a value when there is a purpose, i.e. there has to be a question to be answered (e.g. improvement of knowledge and generation of insight from a scientific perspective, or making informed decisions about design, procurement, development or routine operation of a HIS).

(ii) **Evaluation supports reflective practice.** Every successful organisation and conscientious practitioner evaluates the outcome of their decisions to see whether the intended goals are obtained. Evaluation of health information systems supports the continuous monitoring, review, and adjustment of their planning, development, implementation, and/or operation. Evaluations also support reflective practice in health informatics in general, enabling the emergence of an evidence-based health informatics profession.

(iii) **Evaluation is a challenging endeavour.** Many actors in a health organisation are affected by ICT. Hence, various viewpoints and aspects can be considered in an evaluation. In addition, the organisational, economic, and legal environment in which the health information system has to operate is in a constant change. To complicate issues further, technological developments enable functionalities that could not have been foreseen when the information system was planned. Evaluation of health information systems therefore has the challenging task of selecting an adequate methodology to derive valid and timely answers to given questions despite the continuously changing conditions.

(iv) **Evaluation is not free.** Proper evaluations require skills and resources, which need to be planned, procured, and applied; in return the results of evaluation should be anticipated to have added value. This added value need not to be of monetary nature, but can also be of a functional, psychological, or social type as well as in terms of the value of the knowledge gained.

RECOMMENDATIONS

1. **Evaluation should be seen as an ethical imperative**. Information systems are complex, commit scarce resources, directly affect patient care, and apply developing solutions to changing needs. From an ethical perspective, evaluation of HIS has the same role in medical informatics as evidence and audit has in clinical care practice. Furthermore, and in a similar way, it should be seen as desirable to share findings as learning points and knowledge development for the common good across the health informatics and healthcare communities.

2. **Evaluation should be sufficiently funded.** The funding authorities of health information systems (e.g. hospital management) should require – and fund – explicit and continuous evaluation activities during the planning, development, implementation, and operation of the HIS.

3. **Evaluators should be free from pressure.** Planning and execution of an evaluation should be based on professional expertise and be free from any political, managerial, or other pressure with regard to the conclusions of the evaluation. The main concern of the evaluator should be to perform an independent, objective and proficient study that provides the answer to the questions asked.

4. **Evaluation studies should be grounded on scientific theory and rigorous approaches**. Only rigorous scientific grounding will increase their credibility and ease the interpretation of their results. On the one hand, they need to respect the need to comply with the practical information needs and constraints of the actual situation; on the other hand, they should objectively provide evidence for the derived conclusions.

5. **Evaluation methods should be selected with an open mind.** The choice of methods should not be restricted by a single research paradigm, but take into consideration the variety of information needs, available approaches and methods from different professional and research domains.

6. **Reports on methodological and methodical studies[1] should be encouraged.** Scientific journals and conferences should promote further development of evaluation methodologies. Flexible and trans-disciplinary approaches are needed that allow for the complexity of the evaluation to be managed whilst also accommodating changes in the environment during the evaluation study.

7. **Guidelines for good evaluation practice should be made available.** To strengthen future evaluation studies recommendations for best practice should be prepared through a consensus-making approach based on existing experience and sources of knowledge. The recommendations should be widely published, not only in journals for the medical informatics community, but also in journals directed towards other stakeholders in health information systems and health care delivery.

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[1] 'Methodology' means the 'knowledge (logos) of methods', i.e. how to deal with methods, while 'methodical' means that stringency is applied throughout, which is not necessarily implied by the methodology or methods applied.

8. **Terms, concepts and guidelines for reporting on results of ICT assessment studies should be developed.** These should include a set of well-defined common evaluation terms and concepts; they should be agreed and widely published, then adopted by scientific journals and beyond, as presentation standards, and as the criteria for acceptance for publication.

9. **Evaluation should be promoted by centres of excellence.** Such centres should operate on a not for profit basis, not having other commercial interests in health informatics. They can provide consultancy for health care organisations and promote both theory and good practice of evaluation.

10. **Evaluation networks should be established.** These will support the exchange of experience. They should include participants from different professional and theoretical backgrounds as to encourage the trans-disciplinary synergy of evaluation approaches and theories from different domains.

11. **An open access repository about evaluation studies should be established.** This repository should contain information on planned, active and finalized (and also terminated) evaluation studies. Whether or not the outcomes of such studies are (to be) published through the traditional channels, it is important for evaluators to have access to templates or paradigmatic approaches with contact information as well as lessons learned on methodological and practical issues.

12. **Appreciation of methods of evaluation should be part of health informatics curricula**. Each medical informatician should have knowledge of methodologies and methods necessary to accomplish evaluation of HIS. A firm theoretical foundation is needed. Health Informatics curricula can provide such a foundation, preferably with practical exercises included. It should be noted that evaluation is such a complex endeavour that only extensive experience in the real world will make a health care or health informatics professional a professionally qualified expert in evaluation.

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