# Evaluation of electronic medical records

## A clinical task perspective

## Doctoral thesis


## Hallvard Lærum


Photography by Arild Faxvaag, 2000

# LIST OF PUBLICATIONS

1. Lærum H, Ellingsen G and Faxvaag A: **"Doctors' use of electronic medical records systems in hospitals: cross sectional survey."** BM 2001; **323,** 1344-1348.

2. Lærum H, Karlsen TH, Faxvaag A: **"Impacts of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice."** *J Am Med Inform.Assoc*, accepted July 20th 2003.

3. Lærum H, Karlsen TH, Faxvaag A: "**Use of and attitudes to a hospital information system by medical secretaries, nurses and physicians deprived of the paper-based medical record. A case report**." Submitted to *BMC Med Inform Decis Mak* Sept 12th 2003.

4. Lærum H and Faxvaag A: "**Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians.**" Submitted to *BMC Med Inform Decis Mak* July 17th 2003.

# ABSTRACT

Evaluation is a challenging but necessary part of the development cycle of clinical information systems like the complex electronic medical records (EMR) systems. It is believed that evaluations of EMR systems should include multiple perspectives, be comparative and employ both qualitative and quantitative methods. Self-administered questionnaires are frequently used as a quantitative evaluation method in medical informatics, but very few validated questionnaires address clinical use of EMR systems, and comparative investigations are scarce.

A task-oriented questionnaire has been developed for evaluating EMR systems from the physician's perspective. The key feature of the questionnaire is a list of 24 general clinical tasks. The list of tasks is applicable to physicians of most specialties and covers essential parts of their information-oriented work. The list appears as in two separate sections, about EMR use and task performance using the EMR, respectively. Using the questionnaire, the evaluator may quickly estimate the potential impact of the EMR system on health care delivery. Problematic areas may be found by identifying clinical tasks for which the EMR system either is not used, or for which performing the task is more difficult when using the system. These results may be compared across time, site or vendor. The development, application and validation of the questionnaire is described in this thesis. Its performance is demonstrated in a national and a local study.

In addition to underscoring the performance of the questionnaire, the demonstration studies had interesting results of their own. The national study showed that a considerable proportion of the functionality offered by the EMR systems is not used by the physicians. The local study showed that scanning and eliminating the paper-based medical record in middle-sized hospital is feasible. All physicians used the EMR system more much frequently, and while a considerable proportion of the internists found important tasks more difficult, most physicians found their EMR-supported tasks easier to perform. However, the medical secretaries in this hospital were considerably more satisfied with the system, and overall seemed to benefit more from this change in the work environment than both the physicians and the nurses.

The questionnaire presented here may be used as part of any evaluation effort involving the clinician's perspective of an EMR system.

# PREFACE

## Medical informatics as a field of research

Medical informatics is a relatively new field of research related to management of health related information, in its widest sense. It is multidisciplinary by nature, as it lends methods and theories from the fields of medicine, computer science, sociology, psychology, ethnography, philosophy, pedagogics and more. A good definition of medical informatics is quite simply a "*science that addresses how best to use information to improve health care*."[1] More elaborate definitions exist [2;3], particularly considering the more inclusive "health informatics" term.

Current research in medical informatics focus on subjects like information needs of health care workers and patients, evaluation of health oriented software and technology and standardization of clinical information structure. In addition, new technology with relevance to health care like natural language processing and various computerized pattern recognition techniques are investigated. Important journals in this field are Journal of the American Medical informatics Association[4], International Journal of Medical informatics[5], Methods of Information in Medicine[6] and BioMed Central Medical informatics and Decision Making[7].

## Acknowledgements

This doctoral thesis is a part of *Kvalis*, a multidisciplinary research project on quality assurance of electronic medical records in hospitals, funded by the Research Council of Norway.

The research was carried out 1999-2003 at the Faculty of Medicine in the Norwegian University of Science and Technology, Trondheim. Due to changes in the organizational structure of the faculty and the absence of an institute dedicated to medical informatics, I have been affiliated with several institutes; Institute of Physiology and Biomedical technology (now a part of Department of Circulation and Imaging), Institute of Bone and Joint diseases, (now a part of Institute of Neuromedicine) and Institute of Applied Clinical Research (now a

part of Department of Cancer Research and Molecular Medicine). In 1999-2001, I performed my work at the premises of the Institute of Applied Clinical Research. When the DigiMed Centre (an innovation centre in health technology, informatics and communication, www.digimed.no) was formed in 2001, I continued my work here.

First of all, I wish to thank my three unique supervisors. *Arild Faxvaag* deserves a heartfelt gratitude for his unlimited support and friendship, his visionary and thought-provoking insight in our countless discussions, and for never stopping to believe in me. I thank *Lars Aabakken* for his timely and benevolent comments and his constant virtual presence despite the fact that he lives and works in Oslo. Thanks are also due to *Stein Samstad* for getting me into this project, and for his judicious comments in our periodic but important discussions.

I thank my dear colleagues *Gunnar Ellingsen*, *Gro Underland*, *Eric Monteiro* and *Aksel Hagen Tjora* in the Kvalis project for their company, knowledge and friendship in walking the long and winding road with me. At Sørlandets Hospital HF Arendal I thank *Tom Hemming Karlsen* for our excellent collaboration on the evaluation of the electronic medical records system in this hospital, and *Gerd Gulstad* for her help and support. At the Institute of Applied Clinical Research, *Stein Kaasa* and *Turi Saltnes* deserves gratitude for gladly sharing their extensive knowledge on questionnaire methodology and design with me. At "NTNU videre", I thank *Mari Sæterbakk* and *Astrid Bye* for helping me coordinate the 3rd Scandinavian University course in Medical Informatics in Trondheim, September 2.-4. 2002. Thanks are also due to *Christian Nøhr* and *Jytte Brender* at Aalborg University and the Virtual Centre for Medical informatics and *Paul Gorman* at DMICE, Oregon Health and Science University for inspirational discussions on evaluation issues within medical informatics. In the surveys, observations, and interviews, I thank the 696 physicians, nurses, medical secretaries and patients for their time and participation, without whom this thesis would not be possible.

Finally, I thank my dear wife, Tina, for her always being there for me, and our two children Matilde (5) and Hans Torstein (3) for reminding me of the important things in life.

## Definitions

| | |
|---|---|
| Assessment | An overall term. The act of performing evaluation, verification and validation[8]. See also *evaluation*, *verification* and *evaluation*. |
| Data | Basically, symbols[8]. The number in a laboratory analysis of blood creatinine level, or the resulting image of a radiological investigation. See also *information* and *knowledge*. |
| Evaluation | The act of measuring quality characteristics[8]. E.g. how fast does the system respond to the user's commands? What is the average hospital stay length? See also *validation*, *verification* and *assessment*. |
| Information | Interpreted or organized data[9]. E.g. "severely elevated and increasing creatinine levels, indicating immediately need for haemodialysis" or "complicated fracture of the femur, indicating need for surgery". See also *data* and *knowledge*. |
| Knowledge | Rules, descriptions and models based on scientific evidence, applicable to the whole of or parts of a population. E.g. the fact that a patient's airways are unobstructed is information. The fact that humans need unobstructed airways to survive is knowledge. See also *data* and *information*. |
| Method | A formalized description for accomplishing a working process. E.g. evaluating user satisfaction with an electronic medical records system by means of a questionnaire[8].The distinction between method and technique is often blurred. See also *methodology*. |
| Methodology | A consistent and coherent set of methods covering the entire set of working processes to accomplish a given task. E.g. the choice and sequence of methods for evaluating certain aspects of an electronic medical records system[8]. See also *method*. |
| Validation | The act of comparing the measured quality characteristics (or a property of an object to be studied) to a stated goal or frame of reference[8]. E.g. is the |

effect of the system what we hoped for? See also *evaluation, verification* and *assessment.*

Verification — The act of checking well-defined properties of an object against its specification[8]. E.g. is the system really offering the functionality its vendor claims it to be? Does the system stop running when performing certain functions, due to fatal coding errors? See also *validation*, *evaluation* and *assessment*.

# GENERAL INTRODUCTION : INFORMATION IN HEALTH CARE

## Information in health care

Health care is dependent on information. Hospitals are daily handling and processing unfathomable amounts of information in their routines regarding diagnostic investigation, treatment and patient care. We don't know just how much information is gathered, filtered, processed and communicated by health personnel, but the size and scope of the paper-based medical record gives us a hint. Its size is illustrated by the fact that a 900-bed Norwegian hospital typically needs 10.000 meters of shelf space to archive its paper-based medical record. Its scope is illustrated by the size of the word's largest controlled medical terminology (metathesaurus), the Unified Medical Language System. By January 2003, it contained 875 255 concepts and 2.14 million concept names[10]. All of these concepts are expected to be found in a medical record.

Physicians, like all other types of health personnel, constantly perform decisions regarding health care delivery on behalf of the patient. The numerous information sources available to the physicians provide the very material these decisions are made of. The information theory of Shannon [11] fits this decision-making process well[12], as it describes information as a reduction in uncertainty. However, as most of the clinical decisions are made with some remaining uncertainty, the completeness, accuracy and validity of this information easily shape the physicians' decisions. Incomplete or inaccurate information may delay or even hamper the right decisions. Traditional paper-based information sources, like the paper-based medical record, provide very little structuring of the clinical information, which makes finding the right information a challenge. In addition, the information commonly is scattered over several sources, be it various media or other people. These factors are perhaps the reasons why large shares of a physician's time are devoted to gathering and verifying clinical information [13].

## The need for better handling of information in health care

Considering the efforts made to gather the necessary clinical information, evidence is appearing that the strategies behind the efforts are not sufficient to navigate the current abundance of clinical information[14]. According to the report "To Err is human " from Institute of Medicine, US [15], the number of preventable medical errors seem to be on the rise. In year 2000, hospital admissions caused by medical errors comprised 7% of all hospital admissions in the US. Moreover, the number of deaths due to medical errors reportedly exceeded that of traffic accidents. In this situation, a better way of handling clinical information is indeed called for.

## The promise of computers

The computer, with its amazing speed and capacity, should be able to assist the health care system in handling of its vast amounts of information. Even as the first digital computers started appearing in the late fifties [3], high hopes were held for their impact. The vision of digital manipulation of data might be formulated as providing the right *information* at the right *time* at the right *place* to the right *people*. The right information may be found by searching and reusing clinical information structured in one or several of virtually countless dimensions, making it easier to identify pathological processes. The right time may be met by instantaneous access to information in vast databases or by instantly performing complex calculations, reducing the time needed to identify a diagnosis. The right place may be reached by means of large computer networks like the internet, or by wireless communication and mobile computers, bringing the health care process closer to the patient. The right people may be selected by means of electronic authorization and cryptographic methods. Today, computers still serve a fragmented role in clinical work. The dream of a fully computerized clinical environment has nevertheless been kept alive, despite its lack of fulfillment through five decades of exponential increase in capacity and computing power. The core of such a computerized environment is the electronic medical record, the subject of study in this thesis.

# The electronic medical record (EMR)

## Defining an EMR

The electronic medical record (EMR) may in its simples form be regarded as an electronic version of the paper-based medical record. It is the repository of clinical information on which health personnel base their decisions regarding health care of the individual patient. However, its content is not universally defined in the literature, and consequently, the concept is named in a multitude of ways (Table 1).

| Full name | Acronym | Comment |
|---|---|---|
| Computerized Patient Record [16] | CPR | An integrated system of systems, spanning a range of institutions |
| Electronic Patient Record [17] | EPR | |
| Patient Care Information System [18] | PCIS | |
| Point Of Care Clinical Systems [19] | POCCS | Focus on information use, e.g. physician order entry |
| Electronic Health Record [20] | EHR | Information from all health institutions of all levels, including information provided by the patient, e.g. life style, smoking habits etc. |
| Health Information System [21] | HIS* | Health related systems that may or may not include the medical record |
| Clinical Information System [22] | CIS | Health related systems that may or may not include the medical record, but which is directed towards clinical use. |
| Electronic Medical Record [23] | EMR | The most common term |
| Medical Records Systems, Computerized [24] | - | The MeSH term |

Table 1 Siblings of the electronic medical record. *This acronym as also used for “Hospital information system.”

All of these systems contain information used for clinical decisions, but their contents are spread out in three dimensions (Table 2).

| Dimension | Comment |
|---|---|
| Information sources | What type of clinical information the system should contain, e.g. medical narratives, data from diagnostic instruments, lab data, etc. |
| Users | What type of personnel the system is intended for, e.g. physicians, nurses, clerical staff, administrators, etc. |
| Institutions | What type of institutions the system is serving (e.g. specialist or general hospitals) and what levels of health care the system should integrate, ultimately including the patient |

Table 2 Dimensions of electronic medical records and sibling systems

The differences between the terms in Table 1 should be regarded as arbitrary. None of the EMR systems implemented today are complete in its strictest sense, in neither of the dimensions shown in Table 2. No EMR system integrates all possible information sources, suits all users' needs, is adapted to all kinds of institutions or integrates the health care system from top to bottom. Whichever term used, the reader or evaluator needs to precisely learn the anatomy of the system in question.

### *HIS = EMR + PAS*

When reading about EMR systems and their siblings, one will encounter the general term "hospital information system" (HIS). A HIS is a computer system designed to support the comprehensive information requirements of hospitals and medical centers, including patient, clinical, ancillary and financial management [9]. Such systems include information needed for clinical work, but also administrative information needed to run the hospital as a business. Systems managing the latter type of information are called patient administrative systems (PAS) when they stand alone. PAS systems are much more common than EMRs, and have often preceded implementations of EMRs (unpublished results). Consequently, the patient identity is commonly held in PAS systems when the EMR is held separate from PAS. In addition, selected clinical information like diagnoses and contact history is stored in the latter. Despite the overlap in contents, the two subtypes of hospital information systems serve completely different needs (clinical and administrative, respectively) providing one of very few clear limits to the EMR concept.

### *The distinction between the EMR and the EMR system.*

The EMR term is commonly used when data structure as well as functionality is discussed. However, data structure is a property of the information contained in the *EMR*, and functionality a property of the *EMR system*, i.e. the software handling this information[25]. This distinction means that splitting "EMR" into these two terms is useful in some discussions. For example, in discussions regarding end user computing satisfaction[26], the quality of the data in the EMR is commonly handled separately from the quality of the functions handling it. When several health personnel are delivering clinical information with few or no restrictions from the system handling it, the quality of the data may be perceived as a product of the routines

and personal style of each health personnel, rather than of the functionality of the EMR system. Further, an EMR could hardly offer computerized physician order entry, but an EMR system could. Then again, the data and the functionality of and EMR system may not necessarily be separated. This is partly due to proprietary formats of EMR data and poor data export functionality, but also due to the fact that a given functionality is dependent on a suitable data structure. On the other hand, when data input is highly structured, the quality of the data is highly dependent on that of the EMR system functionality. Despite our splitting of the EMR term, the concepts EMR and EMR system are nonetheless closely related. Perrault and Shortliff have chosen a different division of the CPR (computer-based patient record) from the CPR system9, but the latter term is analog to "EMR system", which is the term used most frequently in this thesis.

### *The EMR system offers more than clinical information*

The all-embracing view of the EMR content may be extended to what clinical work processes the EMR system should support. Since information essential to a great majority of clinical work processes may be found in an EMR system, providing support for all of them may appear as a tempting goal for a developer. This ambitions goal explains the "sprouting" of functionality seen in a number of EMR systems, making them into extremely complex applications, being much more interactive than passive information repositories[16]. The sprouting of EMR's functionality may be understood by the information needs of a health care worker when caring for patients. For the physician, the information needs have been categorized as shown in Table 3.

| Type of information | Description | Examples | Usual sources |
|---|---|---|---|
| Patient data and information* | Refers to a single person | Medical history, physical exam, laboratory data | Patient, family and friends<br>Medical record |
| Population statistics | Aggregated patient data | Recent patterns of illness<br>Public health data | Recent memory<br>Public health departments<br>Journal literature |
| Medical knowledge | Applicable to many persons | Original research<br>Textbook descriptions<br>Common knowledge | Textbooks<br>Consultants, colleagues<br>Local |
| Logistic information | How to get the job done | Required form<br>Preferred consultant<br>Covered procedure | Policy & procedure manual<br>Managed care organizations |
| Social influences | How others get the job done | Local practice patterns | Discussion with colleagues |

Table 3 Types of information used by clinicians, as defined by Gorman [27]. An adapted version of Gorman's table occurred in the opening article of the "Information in practice" section of the British Medical Journal[28]. *The original term is "patient data".

The patient data and information goes without saying, but the other types of information might need some explanation. First, information regarding population statistics may seem only remotely interesting to a practitioner, but it makes a number of diagnoses considerably more accurate. For example, a swollen lymph node in the neck could mean tuberculosis in deprived areas, but rather a harmless sore throat or perhaps mononucleosis in wealthy areas. Second, information regarding updated medical knowledge is undoubtedly needed when caring for patients, and the traditional way of getting this information is by medical text books or stand-alone electronic medical references. However, searches for relevant and updated medical knowledge are much faster and more convenient when they are initiated from existing information like problem lists or diagnoses. Further, the proximity to the patient data in the EMR allows for interesting ways of bringing the medical knowledge to the physician, for example by clinical reminders. Third, information regarding logistic details may seem less relevant than the aforementioned information types. Never the less, these details are the foundation of effective execution of the clinical decisions. In this respect, computerized physician order entry (CPOE) represents an ultimate facilitation for ordering lab test, referrals or medical treatment, by both providing the logistic information and the infrastructure needed to carry it out. Fourth, information regarding social influences may not easily be integrated into the EMR, as this information rarely is made explicit in health organizations. However, facilitation of communication with colleagues may make this kind of information more accessible by providing an informal arena for exchange of suggestions and ideas. In sum, the information needs of physicians and other health personnel seem closely connected to the development of extended functionality in modern EMR systems.

### *Collaboration through an EMR system*

As health personnel never work alone in a hospital, communication and collaboration are necessary between all involved health personnel regarding issues related to each of the information types shown in Table 3. This adds a whole dimension to the functionality need already outlined. Communication of patient data and information is found when a nurse describes observations and concerns of the patients to a physician on pre-round meetings and spontaneously during shifts. Communication of population statistics, medical knowledge and local practice patterns is found during consultations between physician colleagues, and communication of logistic information is typically found between nurses and newly employed physicians. All of these contexts of communication may be supplemented by functionality in

the EMR system, by the potential benefits of information reuse and accessibility, and by the fact that simultaneous attention of both communicating parties is not necessarily needed.

With the EMR system at the core, the way health care is delivered will change dramatically. Just like the properties of paper has shaped the paper-based medical records for support of the health care process, the properties of digital media seem to shape the EMR into an even more complex object. It is not just about "putting electricity to paper" (Pia Elberg, personal communication 1999).

### The paper records and manual routines have some advantages

In our fascination for the powerful computer technology, it is easy to overlook the strengths of current clinical work routines. These routines have been molded by the challenges of everyday clinical work for well over a century [29], and has proven itself as the principal way of handling clinical information in hospitals. Despite the shortcomings of paper-based medical records considering missing records, frequent duplication, large bulk, high total cost and questionable confidentiality [30], the paper-based medical record has yet some advantages. Some of them are listed in Table 4 below.

| **The paper-based medical record is:** | |
|---|---|
| Stable | It doesn't stop working due to some hidden error within the paper fabric and it doesn't need electricity or batteries. |
| Durable | Paper of high quality lasts for hundreds of years, completely outperforming even the most durable of digital media. It is not immediately ruined by water, and it easily withstands a drop to the floor |
| Flexible | It doesn't dictate the way the user must enter the data. |
| Easy to use | It requires no installation and very little training, and everybody in a hospital already know how to use it. |
| Mobile | Excerpts or summaries of medical records may be carried in your pocket, and unfolded for effective viewing. Only the largest of medical records match the weight of mobile computers that provide screen sizes comparable to paper sheets. |
| Fast | Since no booting, log-in or ordering of a search command is necessary, starting a search in paper-based medical record is instantaneous. Reading text on paper is faster than reading on screen [31], and spreading paper out on a table provides a large space suitable for skimming of text. This space is matched by extremely few computer displays. Finally, experienced users may use visual (e.g. color) and tactile (e.g. stiffness) clues of specific document types highly effective in combination with manual browsing techniques (e.g. leafing through the pages using the thumb) and knowledge of how documents are sorted in the medical record [32]. |
| A physical object | Since a physical object may be placed in a specific location, this placement may serve as a signal within an organization and thus provide information about its state in a given work process. |

Table 4 Advantages of paper and the paper-based medical record

### *Collaboration by traditional methods*

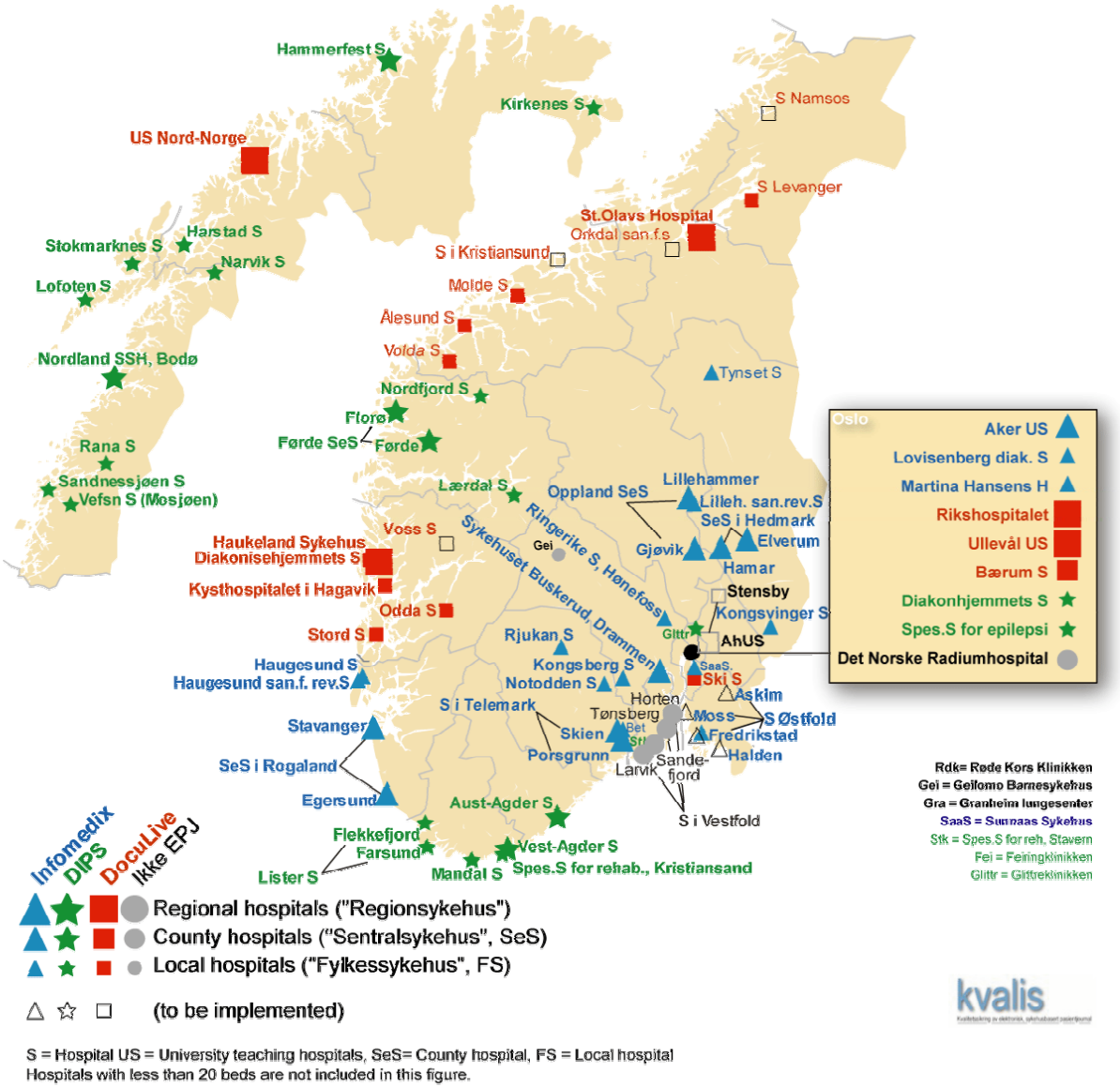
The flexibility of paper is further demonstrated in how forms are used in a hospital organization, where several professions communicate and cooperate using the same forms. As Berg puts it: "*When different individuals work with the same prestructured forms and checklists. they can anticipate each other's past, current and future activities – and track each other's activities through changes made on the form*" [29]. Without a comparable mobility and flexibility to that of paper, digital media will have a very hard time trying to duplicate this role. The advantages of the paper-based medical record and its coordinating role in hospital organizations should be kept in mind when trying to replace it with an EMR. It has been estimated that 45-50% of technical sound information systems in hospitals fail, mostly due to user resistance and staff interference [33]. The possible advantages of existing routines should indeed be considered when trying to explain such failures.

## Dissemination of EMR systems in Norway

In Norway, EMR systems are quite common, both among primary care physicians [34] and in hospitals [35]. In hospitals, three off-the-shelf EMR systems are available. Their distribution is shown in Table 5 and Figure 1, below.

| EMR system | A. Hospitals | B. Beds (percent of all beds) | | C. Beds with implemented EMR (percent) | | D. Vendors (URL) |
|---|---|---|---|---|---|---|
| DIPS | 23 | 2463 | (19) | 2463 | (100) | DIPS ASA (www.dips.no) |
| DocuLive EPR | 20 | 5668 | (43) | 4332 | (76) | Siemens (www2.siemens.no/med/) |
| InfoMedix | 20 | 4179 | (32) | 3720 | (89) | Tietoenator HealthCare (www.infomedica.no) |
| Other | 4 | 38 | (0.3) | 38 | (100) | - |
| None | 3 | 747 | (6) | 0 | (0) | - |
| *Sum* | *72* | *13105* | | *10553* | *(81)* | |

Table 5 EMR systems in Norway as of August 2002 [35].




S = Hospital US = University teaching hospitals, SeS= County hospital, FS = Local hospital
Hospitals with less than 20 beds are not included in this figure.

Figure 1 EMR systems in Norwegian Hospitals as of august 2002 [35].

The three systems are “Infomedix”, “DIPS” and “DocuLive EPR” (Table 5). Infomedix and DIPS are both full hospital information systems  while the DocuLive system communicates with various third party PAS. The clinical information is predominately stored in the form of free form text in documents. The documents are categorized and sorted by a national standard, described in paper 2. On the detailed level, only clinical biochemical lab data and diagnoses are found structured by a common standard. The history of the systems, particularly regarding the DocuLive system, has been described by Ellingsen & Monteiro[36]. A review of the functionality in the implemented systems is found in paper 1 in this thesis, and in a

Norwegian version of it, appearing in *Tidsskrift for den norske lægeforening* (Journal of the Norwegian medical association) [35].

### *The definition of an EMR system used in the national investigation*

In the national investigation in 2001[37], we learnt that all of the EMR systems were able to contain essential clinical information. However, the actual implemented functionality of a given system varied considerably between hospitals, as well as the actual software versions of the installed systems. To cope with this, we decided upon a minimal condition for inclusion of a given hospital. The EMR system should at least contain medical narratives (admission reports, progress notes, discharge reports), directly or indirectly updated by and electronically available to the physicians. For the sake of argument, I will use this minimalistic definition of the EMR in this thesis, despite the fact that it stands in contrast to the definition in the Norwegian EMR standard of 2001[38]. Here, the EMR is defined to contain "at least the information equivalent to all information that could be archived in a paper-based medical record." Except from EMRs in hospitals that scan all of its paper documents (paper 2 and 3), no such EMR exists today.

# SPECIFIC INTRODUCTION: EVALUATION OF EMR SYSTEMS

## About evaluations

### What does evaluation mean?

In the dictionary, to evaluate means "*to determine the significance, worth, or condition of usually by careful appraisal and study"* (Merriam-Webster's online dictionary Sept 2003). In other words, it is a part of investigating whether certain activities have the desired effect or not. Evaluation is a challenging yet necessary part of the development cycle of information systems like the electronic medical records (EMR) system. It is generally a process for which there are many definitions. Brender defines evaluations as "*the act of measuring quality characteristics"*, validation as "*the act of comparing the measured quality characteristics to a stated goal"* and the combination of the two as assessment. However, in the literature, the evaluation term is frequently used interchangeably with the assessment term. In spite of their difference in definition, the effect of mixing these terms is limited. The methods selected for evaluation must be strongly connected to the goals selected for validation, and hence assessment and evaluation would in practice demonstrate few properties that are fundamentally different.

### Reasons for evaluating EMR systems

Evaluation is the necessary closing part of any quality circle. It provides feedback to assure improvement of the given process, for various reasons. On the theoretical side, performing evaluations may be viewed as a duty in being a member of a social system: "*All social institutions or subsystems, whether medical, educational, religious, economic, or political, are required to provide 'proof' of their legitimacy and effectiveness in order to justify society's continued support.*" [39] On the practical side, it may be viewed as a way of improving the quality of health care, and on the political side a way of finding out whether an investment was worth it or not. On the tactical side, it could even be regarded as a remedy against systems stagnation and vendor lock-in, as the difficulty of changing EMR systems reduces the

vendors' motivation for documenting their effects. The objectives of evaluation and assessment may be described as follows [40]:

1. To establish the feasibility of a new project
2. To make organizational investment decisions
3. To review progress of information system projects
4. To assess the impact of an information system on the organization
5. To assess value added by the information system function as a service providing department

Jayasuriya further claims that information systems cannot be viewed in isolation from the complex social and political environments in which they are embedded. As the stakeholders funding an evaluation frequently express an explicit goal for the EMR project to be judged by, evaluation has been identified as a political process[41;42]. In addition, Symans and Walsham argues that evaluation should be viewed not as an approach of a set of tools and techniques but as a process to be understood [43], a view shared by Brender[44]. However, in this expanding universe of evaluation perspectives, a simplistic view might clear things up: Evaluations of EMR system may guide development of tools that help clinicians get their work done.

### What effects of EMRs have been found previously?

Despite the promise of the EMR system, the evidence so far of increased physician efficiency is scarce [45]. Many evaluations of EMR systems have been published internationally, but the variation in choice of methods makes comparison difficult [46], and only a few convincing comparisons exist [47]. Even in single site evaluations, very few reports [12;48] present convincing results indicating improved handling of clinical information. When changes are found, it is often hard to attribute them to properties of the EMR system. For example, MacDonald et al showed a slight reduction in hospital stay length more than ten years after implementing a system containing clinical reminders[49]. They did, however show a much sooner and more convincing effect on resource utilization and practice patterns, a finding also appearing in other studies[19]. Also, convincing reductions in medication errors and costs have also been found when using physician order entry functionality[50]. These results are admirable, but they appear limited in scope. Of the vast functionality of a full EMR system, could it really be that

computerized physician order entry and clinical reminders are the only clinically useful areas? I believe that the answer lies partly in the incomplete and immature constitution of many EMR systems, but also in the way EMR evaluations are performed and presented.

## Evaluation of clinical information systems is different from evaluation of other medical technology

EMR system may be regarded as a medical technology. Traditionally, the randomized clinical trial (RCT) is the method of choice for assessment of medical technologies like heart valve implants, automated drug injection apparatuses and respirators in medicine. Due its success in assessing these technologies, the RCT has been proposed used for assessment of clinical information systems, including the EMR [51]. However, this view has been strongly opposed. In randomized clinical trials of EMR systems, controlled and comparable trial conditions are very hard to achieve, for several reasons. Due to the fact that a full-scale EMR implementation affects the work practice of all employees in a department, whole departments or hospitals usually comprise the object of EMR evaluations. This choice is supported by the fact that the effects of an EMR system are often difficult to contain within the limits of the randomization groups, particularly when control and intervention groups are closely located. The information itself, or the awareness of the fact that it is provided, is easily communicated within a department or a hospital, stimulating physicians in a control group to change their work patterns. Furthermore, making whole hospitals the object of randomization means limiting evaluation projects to very few, extremely large-scale national undertakings. Another difficulty in performing RCTs is that the users of a given EMR system can never be blinded to what type of system they are assigned, violating an important principle in the RCT.
In cross-over studies, the changes in work practices induced by the system may be retained after the system has been withdrawn, providing bias due to the health care personnel's memory. Finally, the randomization procedure of assigning some departments a given functionality and others none may also be considered unethical and not acceptable by the health care personnel [46], particularly when they believe that the functionality will be useful. Mohr sums the RCT up this way: "*The randomized controlled trial design is frequently considered the epitome of the comparison study, because it ensures utmost objectivity. My argument though is that this objectivity comes at a tremendous cost when applied to the evaluation of information systems in the manner devised for controlled trials with physical interventions*."[21]

### *Changes in clinical outcomes are difficult to explain*

Another legacy from the medical domain, clinical outcomes like hospital stay length, prevalence and mortality, may also be difficult to apply to EMR systems evaluations. There are multiple factors between the system and such outcomes, probably more than the researcher can control or compensate for. Introducing an EMR system into a hospital is regarded a major challenge for the institution, and organizational changes may undo, replace or enhance any changes in clinical outcomes measured. Such changes may also not be demonstrable until several years after the implementation, making it difficult to discern the effect of the EMR system from that of other changes in the hospital and its population. This makes changes in clinical outcomes observed during introduction of EMR systems difficult to interpret. Friedman and Wyatt states: "*The causal links between introducing an information resource and achieving improvements in patient outcome are long and complex compared to direct patient care interventions such as drugs...it is thus unrealistic to look for quantifiable changes in patient outcome following the introduction of many information resources until one has documented changes in the structure or processes of health care delivery"*[45] . Collecting data from sources closer to the actual clinical information processing seem necessary.

## Organizational considerations of EMR evaluations

Evaluating an EMR implementation without considering the organizational aspects of it is hardly advisable. One the one hand, personnel in an hospital organization may simply reject an EMR system they do not condone to [52;53], and on the other, the same organization may adapt to and spontaneously compensate for flaws in implemented systems. Indeed, virtually all potential effects of an EMR system may be achieved by organizational changes alone, at least if cost is no issue. Already at the exploration phase of EMR implementations, the principal question arises about whether one should adapt the EMR to the organization or vice versa. The former option could mean an easier implementation by leaving the organization unchallenged, but also that current paper-oriented routines would be cast in concrete. The latter option, adapting the organization to the EMR, could mean a better exploitation of the digital medium, but also making profound changes in how an extremely complex organization do its work, of which the outcome would be uncertain. It has been argued that, unless it is

completely ignored, an implemented EMR will almost certainly bring about changes in how the personnel interact, and how the work is performed[54]. Baseline studies may thus be difficult to interpret when the organization itself has changed by the EMR implementation. On a detailed level, changes in work routines easily means disrupting existing division of labor, leading to resistance and need for renegotiations. Further, differences between professions in work roles, aims, and interpretation of common concepts will strengthen the request for separate information systems. However, the most obvious of all benefits facilitated by EMR systems – to reduce unnecessary redundancy of information work – is limited when reduction of information redundancy between various health personnel is not possible. All considered, organizational issues may cause, block or define effects of EMR implementations, and evaluation projects need to include them in their design, performance and interpretation.

### Evaluation of EMR systems is difficult

Evaluation of EMR systems do not differ much in principle from that of general information systems. Evaluation of the latter is regarded as difficult, due to the multidimensionality of cause and effect and the multiple and often divergent evaluator perspectives[43]. The same holds true for EMR systems, which support a wide range of specialized activities performed by a number of personnel categories all interacting in complex organizations within the confines of health care. It lies, according to Friedman & Wyatt, at the intersection of medicine and health care delivery, computer science and evaluation methodology, all of which are considered notoriously difficult[45]. EMR systems are described as mission-critical, complex systems used in complex organizations [55] by a wide range of users [16] in large numbers. Neither the names of EMR systems and their siblings nor their contents and functionality have been classified in a formal way. It should be therefore be no surprise that there are extreme variations in the way evaluations are performed, be it scope or method. There are, however, principles that may guide the evaluator of such systems.

## Guiding principles of EMR system evaluations

It is generally believed that multiple perspectives need to be considered in EMR system evaluations, and that qualitative and quantitative methods should be integrated when

performing them [46]. While the former may describe the "*what happened"* questions in such evaluations, the latter may describe the "*why did it happen"*, in addition to signaling widespread but difficult to measure effects of the system. The evaluation should include a comparative element [56], which means that some form of reference group or ideally a baseline of the parameters investigated must be ascertained. The former implies a longitudinal approach with repeated studies, and the latter one of large scale involving a number of sites. Evaluations should rely heavily on how humans react to the system [57], which means that at the least the attitudes of the primary users must be taken into account. Since the multi-perspective, multi-methodical and longitudinal approach easily exceeds any perceivable amount of allocated resources, designing evaluation projects means making a difficult choice in phenomena investigated and methods used.

### Performing evaluation studies

Before looking into the details of evaluation studies, the overall process should be considered. A straightforward order of evaluation studies has been defined in PROBE [56]. When performing an evaluation, the evaluator should:

1. Agree *why* an evaluation is needed
2. Agree *when* to evaluate
3. Agree *what* to evaluate
4. Agree *how* to evaluate
5. Analyze and report
6. Assess recommendations and decide on actions.

A more iterative design of evaluation studies are given by Friedman and Wyatt[33], further refined by Berwick [58] and McDaniel [59]. The evaluator should:

1. Select a problem to work on.
2. Organize a team to carry out the improvement project.
3. Diagnose the problem: that is, understand the process of which it is a part and gather information on the process in order to search for root causes of the problem.
4. Plan, test, and implement a remedy guided by process knowledge.

5. Check and continuously monitor performance at the new level, taking further action as needed to modify the remedy

This iterative design is further developed by Brender[54], who suggests that evaluation should be continuous and exist as a process parallel to and interacting with the process of systems development. In addition to the describing the overall design of evaluations, Friedman & Wyatt recommends a certain mindset for such studies:

1. Tailor the study to the problem
2. Collect data useful for making decisions
3. Look for intended and unintended effects
4. Study the resource while it is under development and after it is installed
5. Study the resource in the laboratory and in the field
6. Go beyond the developer's point of view
7. Take the environment into account
8. Let the key issues emerge over time
9. Be methodologically catholic and eclectic.

With a practical framework now in place, we may focus on what and how to evaluate.

## Basic types of evaluations and methods

### *Formative and summative evaluations*

Evaluation projects may be classified as either formative or summative [60]. An evaluation classified as formative is conducted during the lifetime of a project and has the intention of providing direct input to development and design. Such evaluations are typically performed during the exploration phase and under development. Various usability methods [61;62] are formative in nature, as they effectively identify and describe problematic aspects of solving defined tasks using the system. An evaluation classified as summative is conducted at the end of project, and has the intention of assessing concrete achievements of the system. Summative evaluations may address questions like "does the system produce the desired results?" The method of balanced scorecards is summative in nature, and it integrates a comprehensive set of measured properties of a given system to provide a balanced evaluation.

### *Objectivist and subjectivist evaluations*

Friedman & Wyatt broadly categorizes all evaluation methods as either objectivist or subjectivist. The objectivist category is derived from the logical-positivist philosophical orientation. It generally puts properties of the resource under study, i.e. it suggests that the most interesting attributes may be measured, with all observations yielding the same result. Most quantitative methods such as user surveys, hospital's activity parameters, system audit logs and cost/benefit studies belong to this category. The subjectivist category, on the other hand, suggests that what is observed about a resource depends in fundamental ways on the observer, and hence different observers may legitimately come to different conclusions. In this view, evaluation should be viewed as an exercise in argument, rather than demonstration, because any study appears equivocal when subjected to serious scrutiny. Many qualitative methods, such as open-ended interviews, observations and document studies, belong to this category.

## Evaluation frameworks for EMR systems: dimensions and phases

When designing their projects, the evaluators of EMR systems must choose among thousands of possible effects, phenomena and parameters, and a list of well over hundred accompanying investigation methods. Not surprisingly, this choice of method vary markedly, and as Moehr observes: "*while the pursuit of a homogeneous methodology may continue to haunt us, it may prove to be an elusive goal.*" [63] We should not expect or want a unified set of perspectives in various health organizations, but the similarities between them should nevertheless be evident. One way of meeting the challenge of choosing perspectives and investigation methods is by organizing them semantically into dimensions, and contextually into phases.

### *Evaluation dimensions*

The countless aspects of EMR systems may be organized in dimensions. These dimensions do not provide specific advice on what to investigate, but help the evaluator design the evaluations broadly. A number of authors have proposed sets of dimensions design to cover the field of health information systems evaluation.

| | Dimension | Based on | Example |
|---|---|---|---|
| 1 | Technical systems performance | Reliability, efficiency of system | System response time, downtime |
| 2 | User evaluation of technical system | Functionality, usability | Task match, ease of use, ease of learning |
| 3 | User performance and satisfaction | How the health personnel do their work | Task performance |
| 4 | Socio-technical systems performance | Changes in the socio-technical system | Multidisciplinarity in clinical work, work role satisfaction |

Table 6 Evaluation dimensions by Eason

The dimensions presented by Jayasuria [40], builds upon the work of Eason in 1989, expands the strictly technical performance to user satisfaction of both technical system and own activity, and includes the socio-technical concept (Table 6). They thoroughly emphasize the importance of user participation and the interaction between hospital organization and information system.

| | Research questions |
|---|---|
| 1 | Does the system work as designed? |
| 2 | Is the system used as anticipated? |
| 3 | Does the system produce the desired results? |
| 4 | Does the system work better than the procedures it replaced? |
| 5 | Is the system cost-effective? |
| 6 | How well have individuals been trained to use the system? |
| 7 | What are the anticipated long-term impacts on how departments interact? |
| 8 | What are the long-term effects on the delivery of medical care? |
| 9 | Will system implementation have an impact on control in the organization? |
| 10 | To what extent do medical information have impacts that depend on the practice setting in which they are implemented? |

Table 7 Evaluation questions by Anderson & Aydin

The well-known ten evaluation questions by Anderson & Aydin (Table 7) are not really dimensions, but serve a similar purpose by defining a broad scope for the evaluator.

| Perspectives<br>*Themes/dimensions* | A. Structure | B. Process | C. Outcomes |
|---|---|---|---|
| *1. Strategic* | Vision for EMR, link to local strategies for health | | |
| *2. Operational* | Infrastructure for information processing | How the EMR contributes to the delivery of care | |
| *3. Human* | Culture and organizational readiness | Examining how the individuals were involved in the implementation | Examining the way the EMR affects the individuals |
| *4. Financial* | Business case for EMR | Risk and risk management | Did the hospital save money? |
| *5. Technical* | Underlying IT issues | EMR implementation path | Technical performance, system response time, system stability |

Table 8 Perspectives and dimensions by Heathfield et al

Heathfield et al[60] goes one step further by defining both dimensions (called "themes") and the perspectives of structure, process and outcomes. They use a matrix of the dimensions and perspectives to organize the aspects of EMR systems evaluation (Table 8)

| | Dimension of impact | Example |
|---|---|---|
| 1 | Safety | Medication errors |
| 2 | Quality | Compliance in care pathways and guidelines, use of evidence to inform care decisions, quality of clinical documentation |
| 3 | Efficiency | Process of tests, faster treatment, cost per stay |
| 4 | Organizational | Work process changes, organizational culture |
| 5 | Technical | System response time, access to terminals, interface usability |

Table 9 Dimensions of impact by Westbrook & Goslin

The dimensions by Westbrook & Goslin are less comprehensive than that of Heathfield et al, but have an appealing simplicity to them (Table 9).

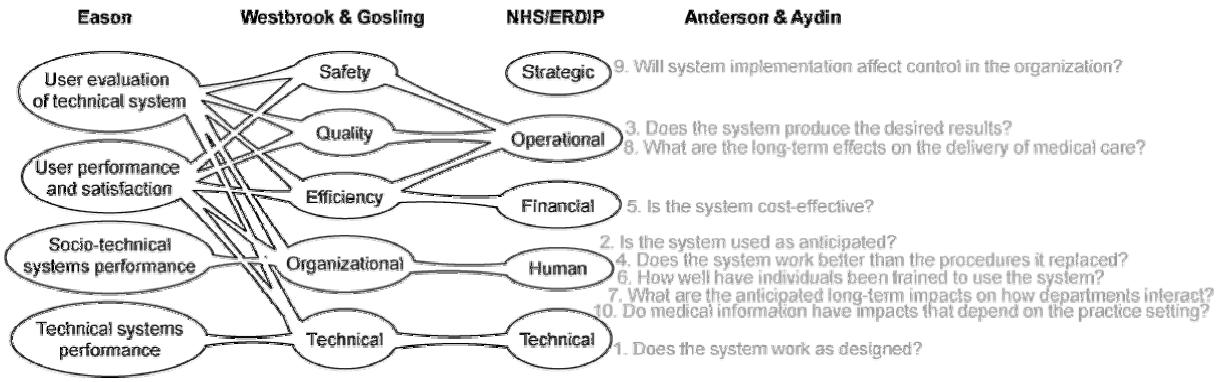



Figure 2 Combination of dimensions of EMR evaluation. Relations of the dimenstions are shown by the strings drawn between them.

When combining the four sets of dimensions into a single diagram (Figure 2), it is obvious that the dimensions cover different areas and that they are not directly interchangeable. Despite the complexity of the diagram, the combination of dimensions should provide a more complete picture than each set considered separately.

### *Evaluation phases*

Evaluation aspects and methods may be organized contextually into phases. This fits with the idea that evaluation should not be considered a singular event, but rather a continuing process. Several authors have described the life cycle of an information system in phases, each requiring separate evaluations and representing particular challenges for the evaluator. Common to all authors is the demand of a longitudinal approach.

| | Assessment phase | Development phase | What to evaluate |
|---|---|---|---|
| 1 | Explorative assessment | Explorative | user requirements |
| 2 | Technical validity | Development | Functional specification, prototyping |
| 3 | Usability | Maintenance | Application |
| 4 | Impact | Evolution | Impacts of application on health care |

Table 10 Dynamic assessment methodology by Brender

Brender [8] suggests a life cycle having four phases, in which evaluation and development interact continuously (Table 10).

| | Evaluation phase | Main question |
|---|---|---|
| 1 | Verification | Has the system been developed according to its specification? |
| 2 | Validation | Does the system perform the tasks for which it has been designed in the real working environment? |
| 3 | Evaluation of human factors | Will the system be accepted and used? |
| 4 | Evaluation of clinical effect | How does the system affect patient outcome? |

Table 11 Evaluation phases described by Bürkle et al

Bürkle et al [64] describes phases very similar to that of Brender, but expands them by replacing "usability" with the broader term "evaluation of human factors" (Table 11).

| | Evaluation time point | Comment |
|---|---|---|
| 1 | Before implementation | Achieve baseline data |
| 2 | During implementation | During each stage of a project |
| 3 | Immediately following implementation | Evaluations following implementation are called "operational reviews" |
| 4 | 2 years after implementation | |
| 5 | 5 years after implementation | |

Table 12 Evaluation time points suggested by Heathfield et al

Instead of describing phases, Heathfield et al [60] suggest clear time points at which evaluation should occur (Table 12) for summative evaluations.

| | Evaluation time point | Comment |
|---|---|---|
| 1 | Before implementation | Achieve baseline data |
| 2 | During implementation | Only organizational and technical dimensions |
| 3 | 0.5 year after implementation | |
| 4 | 1.5 years after implementation | |
| 5 | 3 years after implementation | |

Table 13 Evaluation time points suggested by Westbrook & Gosling

The recommendations by Westbrook & Gosling[19] (Table 13) coincide with that of Heathfield et al, except that the evaluations following implementation are performed sooner.

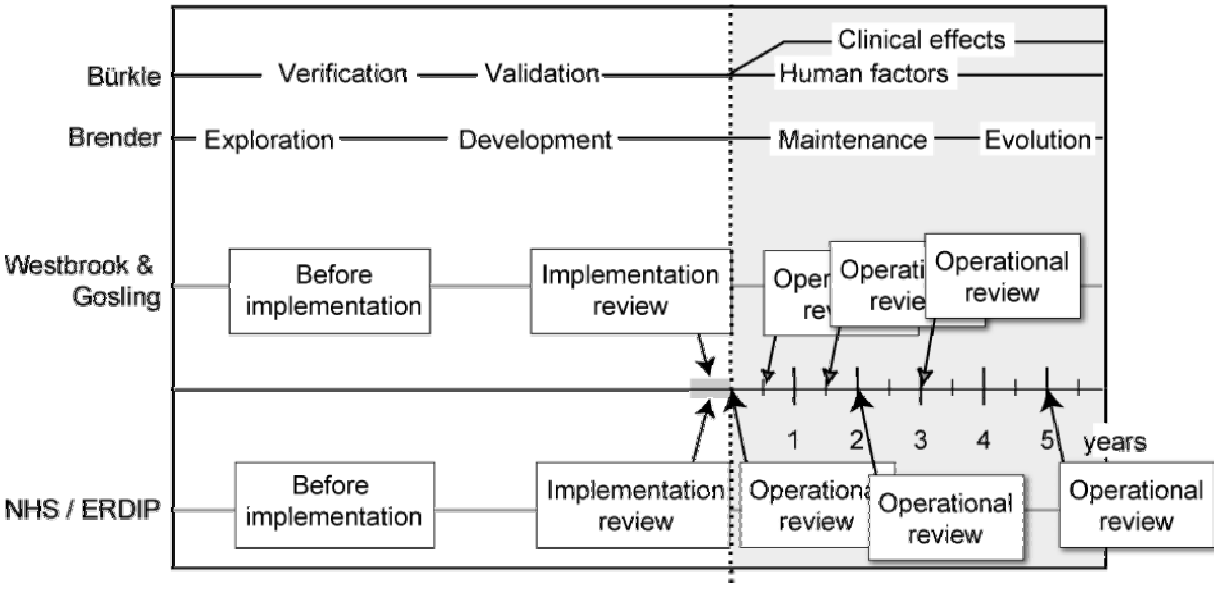



Figure 3 Phases of EMR systems development and evaluation

The dimensions and phases will be further discussed after this thesis' task-oriented evaluation method and its questionnaire has been presented.

## The need for adapted methods

The numerous perspectives to EMR evaluations suggest that they are efforts not to be underestimated in terms of complexity, cost and duration. To cover the various perspectives there are literally hundreds of evaluation methods suitable for various dimensions and phases[33;65]. Practically all of these methods are generic in nature, and need in considerable degree to be adapted to hospital work and computer systems in general and properties of the selected EMR system and health personnel in particular. This distance not only allows for variations in how the evaluations actually are conducted and hence difficulties in comparing various evaluation studies[66], but also adds to the work and uncertainty involved in performing such evaluations[67]. Although generalizable approaches are found[26;47;68;69], the majority of published evaluations employ methods adapted to and used in single sites, or involving single EMR systems. There is a need for methods adapted to hospital work and EMR systems in general, still applicable to various sites and EMR systems from various vendors.

## Research questions in this thesis

The aim of the research project described in this PhD thesis has been to develop an evaluation method adapted to EMR systems in hospitals. The adapted method should be applicable to a number of sites and EMR systems, and allow for comparisons between sites or systems from various vendors. As traditional parameters like changes in clinical outcomes are difficult to link causally to properties of an EMR system, measurements performed in closer proximity to the actual site of impact of such systems were sought after. Successful EMR systems are expected to affect the flow of information in clinical practice, which means that the method should be oriented towards hospital physicians' clinical practice. The aim of the research project called for an explorative approach, in which each research question initiated the next. The research questions in this thesis are presented stepwise here, and the rationale of each step is briefly stated.

### 1. How may the effect of various EMR systems on physicians' clinical practice in various hospitals be evaluated?

*A. What is the level of functionality of current EMR systems?*

To calibrate the method for current EMR systems, i.e. to avoid developing a method based on too high expectations, the functionality and completeness of current EMR systems needed to be described. This is done in the background study, with results appearing in paper 1.

*B. May properties of physicians' clinical practice be described by task-oriented methods?*

The answer to this question (a resounding "yes") was found in the rich literature describing task analysis in general, and in published articles describing approaches to evaluation of EMR systems involving task analysis techniques. This is further described on page 61.

*C. How may elements of physicians' clinical practice suitable for support by EMR systems be validly translated into general clinical tasks?*

Various observational studies of clinical practice as well as interviews were performed during development and validation of a medium-sized, general task list for hospitalists. The results are shown in paper 4.

D. *How may self-administered questionnaires be used to evaluate EMR systems?*
The use of questionnaires is a common method of collecting data, and this method is frequently recommended for selected evaluation questions[16;33;60;65]. However, there are few standardized questionnaires for evaluation EMR systems. This is further discussed on pages 50-54.

E. *What may self-reporting of EMR use and task performance tell us about an EMR system?*
The implications of self-reported EMR use and task performance are described on pages 55-59, and in paper 4.

## 2. How do physicians using various EMR systems respond to task-oriented questions about frequency of EMR use and task performance?

These questions are considered in paper 1 and 2.

A. *Do the physicians use the functionality offered by the given EMR system, and if not, do they report lack of use of such functionality?* *(paper 1)*

B. *What is the state of EMR utilization by physicians in Norwegian hospitals?* *(paper 1)*

C. *How may radical changes in conditions for clinical information work, such as obliteration of paper-based medical records, affect EMR use and task performance of physicians?* *(paper 2)*

## 3. What may similar surveys involving other hospital personnel like nurses and medical secretaries tell us?

This question is considered in paper 3

A. *Are there overall differences in EMR use and task performance between medical secretaries, nurses and physicians using the same system?* *(paper 3)*

### 4. How does the task-oriented questionnaire perform?

This question is considered in paper 4

A. *Are the task-oriented questions difficult to answer for the physicians?* *(paper 4)*

B. *Do the physicians respond to the questions, and are the responses coherent?* *(paper 4)*

C. *How do the task-oriented questions relate to other measurements, like standardized questions about user satisfaction?* *(paper 4)*

The following sections will in general be organized by the papers, which correspond to main research questions 2-4. This is also indicated by the references in parentheses following each question in the section above.

# METHODS

In this thesis, a number of methods have been used. Due to the heterogeneous and complex nature of both clinical work and hospital organizations, methodological rigidity remains a disputable goal by itself. A pragmatic approach has been necessary, to be able to carry out the studies whilst respecting the obligations of participating physicians and other health personnel. To compensate for the lack of exact control of the research environment, I have chosen to maximize the approaches to allow for triangulation. Furthermore, the aim of the thesis – providing advice for evaluation of EMR systems – induced a broad methodological approach. The principal methods are initially described in this section, followed by a review of the individual methods used in papers 1-4.

## The principal methods used in this thesis

I will initially describe the principal methods used in this thesis, i.e. non-participatory observations, interviews and self-administered surveys.

### Non-participatory observations

In observational studies, the researcher participates as an observer in real-life situations relevant to the phenomena under study. In non-participatory observation, the observer avoids interfering with the participants of the situation, apart from presenting himself and ascertaining consent from them. Actions, events and conversations deemed relevant by the observer are transcribed into field notes as verbatim as possible. The field notes are subsequently analyzed qualitatively, basically categorized by theme or phenomenon. As an alternative, observations may be documented by video recordings, and the recordings categorized without transcription using specialized computer software [70]. On basis of the data, hypotheses are developed by integrating the categorized observations. Observations are also frequently used for as a basis for construction of task inventories [71]. In both cases, particularly the latter, knowledge about the situation to be observed is regarded necessary (unless a "value-neutral", non-interpretative observation is sought after). Observational studies provide

highly valid and trustworthy data, but both data gathering and analysis may be extremely time-consuming, and they are not well suited for covert processes like cognition.

### Interviews

Interviews may shed light on processes not suitable for observations. Usually performed one-on-one, the interviews may be structured or unstructured. The former means following a strict interview procedure as in a questionnaire, and the latter means having no preformed questions as in an outpatient consultation (but rather a general goal for the interview). Semi-structured interviews combines the two forms by providing preformed open-ended questions, and being flexible in terms of the order in which the topics are considered. Furthermore, emphasis is placed on the interviewee's ideas and the wider discussions on the topics raised by the interviewer [72]. In general, interviews provide an effective way of gathering considerable amounts of data while being able to monitor and explain questions that are unclear to the interviewee. However, the answers will never be more accurate than the memory of the interviewee, and the presence of the researcher is believed to stimulate bias.

### Self-administered surveys

Self-administered surveys are ideal for acquiring considerable amounts of quantitative data from a large number of respondents. However, the lack of control during the actual data collection makes the results vulnerable to flaws in questionnaire design and wording as well as unforeseen context-specific properties of the respondent. A systematic approach to development and validation of a questionnaire is necessary, making this method considerably more resource-intensive than perhaps expected. Also, low response rates may occur in certain subgroups, lowering the representativity of the results. Since this thesis covers development and performance of a questionnaire, this method is described in more detail in the discussion section (page 48).

## Methods used in each study

The individual methods used in each study are presented here in tabular form, preceded by the intentions of the study. The study subjects and the selection of them are described specifically in the tables, and particular circumstances are commented.

## Methods used in the background study (parts appearing in paper 4)

### *Intentions*

- To review current EMR systems in Norwegian hospitals, their vendors and functionality
- To review the literature on evaluation methods and high-quality evaluation studies
- To study clinical work to supplement and broaden my own knowledge about it, and to observe the information flow that appears in it.
- To develop the first version of a questionnaire covering information-related tasks for physicians
- To translate questionnaires covering user satisfaction and computer literacy

### *Methods*

The methods used in the prestudy (Table 14 ) were aimed at providing a foundation for the development of an evaluation instrument. Regarding development of the instrument itself, no predefined, rigorous method exists, other than a collection of pragmatic guidelines [73]. The existing questionnaires covering user satisfaction and computer literacy were translated as recommended by Fayers & Machin [74]. I translated them from English to Norwegian, and a professional translator (himself being English) translated them back to English. The differences between the original and the retranslated English version were resolved by editing the Norwegian version in collaboration with the translator.

| Method | **Literature search** |
|---|---|
| Subjects | Essentially literature cited in the databases PubMed, BIBSYS and ISI |
| Selection | Reference lists in important papers were used extensively. In direct searches in reference databases, the keywords “medical records systems, computerized”, “evaluation”, “assessment” and “hospital” were commonly used. |
| Comment | Due to the overwhelming combined scope related to the fields of evaluation, health care and information systems, the literature search was essentially exploratory rather than systematic. The resulting literature database contained 412 references (2003-06-13). |
| | |
| **Method** | **Observation, field notes** |
| Subjects | Five physicians working in department of respiratory diseases and department of cardiology, 20 h observation time, covering consultations with both outpatients and inpatients. |
| Selection | Convenience sampling of willing subjects. |
| Comment | The physicians were observed during one week in each department, for a total of 20 hours observation. Seven hours covering 29 patients were transcribed verbatim in the field notes. The field notes were categorized as in hierarchical task analysis. |

| Method | Observation, video taped |
|---|---|
| Subjects | Two physicians working in department of rheumatology, 4.5 h observation time, attending to nine patients in a rheumatology outpatient clinic. |
| Selection | Convenience sampling of willing subjects. |
| Comment | Including willing physicians was challenging. |

Table 14 Methods used in the background study

## Methods used in the national study (paper 1)

### *Intentions*

- To review the current state of EMR systems in Norwegian hospitals, i.e. their distribution and implemented functionality.
- To estimate the potential clinical impact of EMR systems in Norway by assessing physicians' use of such systems for clinical tasks.
- To evaluate the EMR systems by user satisfaction measures.
- To explore computer availability and literacy as cofactors for computer use

### *Methods*

Semi-structured telephone interviews were performed for verification of implemented functionality, and a postal survey to cover the remaining variables

| Method | Questionnaire survey |
|---|---|
| Subjects | 227 of 314 (71%) physicians responded (eight excluded post hoc) |
| Selection | Block randomized selection of 32 medical, surgical or pediatric hospital units in hospitals having implemented an EMR system. All physicians working in the included hospital units were included. |
| Comment | Questionnaire revision 1 was used |
| | |
| **Method** | **Semi-structured interviews** |
| Subjects | 19 representatives of IT departments in hospitals of the units included in study |
| Selection | One subject in each hospital, named by colleagues as central to the EMR implementation process, and therefore assumed knowledgeable of the EMR system. |
| Comment | Semi-structured interviews by telephone, predominately closed questions based on defined minimal requirements of functionality for each task. |

Table 15 Methods used in national study

## Methods used in the local study (papers 2 and 3)

### *Intentions*

- To test the questionnaire in a complete hospital
- To assess the impact of a radical change in work methods in this hospital, by comparing the physician's user satisfaction and frequency of use to that of the national study. (The hospital scanned and obliterated their paper-based medical records.)
- To compare the attitudes and general work patterns of medical secretaries, nurses and physicians regarding the implemented EMR system.

### *Methods*

The evaluation was performed in collaboration with the local evaluation committee in Sørlandets Hospital HF Arendal (previously called Aust-Agder Hospital), lead by Tom. H. Karlsen MD. The survey and the interviews addressed the same topics, the former in more detail than the latter. The interviews preceded the survey.

| **Method** | **Group discussions and open-ended interviews** |
|---|---|
| Subjects | 15 medical secretaries, nurses and physicians participated in 40 h group discussions drawing work-flow charts. Eight to 12 representatives of medical secretaries, nurses and physicians were interviewed for 0.5-2 h discussing the EMR system on basis of the work-flow charts. |
| Selection | Convenience sampling within each profession, aimed at providing a representative selection. |
| Comment | The head of the local evaluation committee in the hospital performed the interviews and analyzed the data. |
| | |
| **Method** | **Informal focus groups (questionnaire development)** |
| Subjects | 4 medical secretaries, 4 nurses and 6 physicians participated separately in informal focus groups, each 4h in two sessions. The content of the questionnaire was discussed and modifications suggested. In particular, separate task lists for the medical secretaries and the nurses was developed. |
| Selection | All available personnel who had participated in the group discussions. |
| Comment | |
| | |
| **Method** | **Questionnaire survey** |
| Subjects | 79 of 85 (93%) medical secretaries, 172 of 235 (73%) nurses, 70 of 80 (88%) physicians responded, all working in Aust-Agder Hospital |
| Selection | All medical secretaries, nurses and physicians working in somatic departments caring for inpatients (i.e. not the psychiatric department). |
| Comment | Questionnaire revision 2 was used, specifically adapted to this hospital. Local health personnel in each department distributed and collected the questionnaires on behalf of the hospital administration and us. |

Table 16 Methods used in local study

## The methods used in the validation studies (paper 4)

### *Intentions*

- To validate and critique the third (and final) version of the questionnaire

### *Methods*

Four studies were performed to validate the questionnaire; a structured interview study for content validation, a post hoc analysis of the local and national study for criterion validation and missing response analysis, a postal survey for test-retest reliability analysis and a scaling study of a non-standard response label scale [75]).

| Method | **Structured interviews** |
|---|---|
| Subjects | 10 physicians, each working in different departments, 1 h interview |
| Selection | Subjects suggested by head of each department, avoiding the most "computer knowledgeable" subjects |
| Comment | A fixed set of 153 questions were asked, the majority pertaining to the tasks defined in the questionnaire. |
| | |
| **Method** | **Post hoc analysis of demonstration studies** |
| Subjects | All physicians in the of national and local study |
| Selection | - |
| Comment | The results were used for missing analysis and criterion validation |
| | |
| **Method** | **Questionnaire, postal test-retest study** |
| Subjects | 52 of 96 (55%) physicians answered the first questionnaire, 37 of 52 (71%) answered the second questionnaire. |
| Selection | Each representing an EMR system, three hospitals were selected for their high degree of implemented functionality. From each hospital, complete names lists of the physicians were gathered in three groups: One for the medical department, one for the surgical department and one for 2-3 smaller departments. 10 or 11 physicians were selected randomly from each of these groups in each hospital, for a total of 102. |
| Comment | The results were used for calculation of Cohen's weighted kappa (a test-retest reliability measure), and criterion validation. Questionnaire revision 3 was used. |
| | |
| **Method** | **Questionnaire, direct VAS scaling study** |
| Subjects | 30 men and women |
| Selection | Convenience sampling of physicians, nurses and others working at the St.Olavs Hospital, NTNU and Sintef Unimed. |
| Comment | The labels for placement on the Visual analog scales were presented in random order. |

Table 17 Methods used in the validation studies

# RESULTS

The structure of the results section is similar to that of the methods section. The main results are initially described in a summary, followed by the individual results of papers 1-4.

## Summary of results

This thesis describes the development, demonstration and validation of a questionnaire. The questionnaire is aimed at measuring the self-reported use of and performance with a given EMR system, for a limited set of clinical tasks that most physicians do regularly.

### Development

The tasks and the task-oriented questions have been developed in an incremental fashion, based on observations of physicians in real-life situations and published physicians' information needs. In the process of condensing the tasks, specific requirements of intended use regarding EMR systems and postal surveys have been followed. The details of the development are described in paper 4.

### Demonstration

The use of the questionnaire has been demonstrated in a national study (paper 1) and a local study (paper 2). In both studies, the response rate was high (72 and 88%) and the proportion of missing responses low (median 7 and 0%, respectively). In the national study, it was shown that a considerable proportion of the implemented EMR functionality was not used by the physicians. In the local study, the paper-based medical record had been scanned and obliterated. As expected, a much higher frequency of EMR use was found. Despite this radical change in work processes, most of the physicians in a majority of departments found the performance of tasks regarding information retrieval easier. The medical department had the highest proportion of physicians reporting that their work had become more difficult, but the proportion of physicians finding their work easier still comprised the majority, even in this department. In addition to using the questionnaire for the physicians, separate versions of the questionnaire were made to survey the medical secretaries and the nurses (paper 3). The comparisons in EMR use (actually a HIS) and task performance between the medical

secretaries, nurses and physicians were more uncertain than that of physicians only, but combined with the difference in user satisfaction and the results from the interviews in this study, it was clear that paper-deprived HIS had simplified the work of medical secretaries, much more so than the nurses and the physicians. This indicated that the questionnaire may successfully be adapted to other EMR user groups in a hospital.

### Validation

Support for the validity of the questionnaire has been provided in the studies appearing in paper 4. The studies cover content validity, criterion validity, missing data analysis and validation of the "Frequency of EMR use" scale.

## Results from the papers

The four papers represent a large body of data. In this section, only the essential results are presented. For further details, see the individual papers.

### Paper 1: Doctors' use of electronic medical records systems in hospitals: cross sectional survey

1. The list of 23 tasks provide a framework for which EMR system may be defined (task 1) and described, and their completeness in functionality adapted for physician's clinical work may be compared.
2. EMR systems are widespread in Norwegian somatic hospitals (77% of hospital beds were covered in 2001). The market is completely dominated by only three EMR systems, making comparisons across various hospitals possible. None of the systems are complete, and there are considerable differences in implemented functionality between the three systems.
3. In current EMR systems, implemented functionality is frequently not used by the physicians, e.g. writing prescriptions.

4. Questionnaires including both user satisfaction and task-oriented frequency of use of EMR systems provide more information than questionnaires consisting of user satisfaction only.

### Paper 2: Impacts of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice

1. A due difference in frequency of use of a given EMR system was found between the physicians working in a hospital that scans and obliterates the paper-based medical record, and those working in hospital that use the same system, but keep and update the paper-based medical record.
2. The difference in frequency of use was striking in tasks regarding information retrieval, but minor in other tasks. All of tasks for which the EMR system was frequently used were found more easily performed by the physicians.
3. Despite the radical change in work practices, the negative impact on user satisfaction was only partial, generally limited to the use of scanned document images.

### Paper 3: Use of and attitudes to a hospital information system by medical secretaries, nurses and physicians deprived of the paper-based medical record. A case report.

1. Questionnaires based on task inventories defined in relatively short focus groups may reveal clear differences in patterns of use of a Hospital Information System (HIS) between medical secretaries, nurses and physicians.
2. In Aust-Agder hospital, the medical secretaries use the HIS routinely for a very high proportion of their defined tasks (15/23), and they find that all the defined tasks were performed more easily than before. These results are accompanied by a considerably higher user satisfaction among the medical secretaries than that of nurses and physicians.
3. The nurses used the HIS routinely for few of their defined tasks (4/23), and they were only moderately satisfied with the system.

4. In the interviews, the medical secretaries said that the obliteration of the paper-based medical record had simplified their work.

### Paper 4: Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians

1. In the interview study, 23 of the 24 defined tasks were found relevant by the ten interviewed physicians. On the whole, their spontaneous interpretation of each tasks coincided well with the task definitions. However, the physicians raised some issues that pointed to possible improvements of the questionnaire.
2. In the two demonstration studies (physicians' responses, papers 1 and 2), the proportion of missing responses in the task-oriented questions was low (median values 7 and 0% regarding frequency of use, and 3% regarding task performance). The response rates for the questionnaire was high (72 and 88%), and the studies provided readily interpretable results.
3. Criterion validity was demonstrated for a majority of the task-oriented questions, using questions on overall EMR use, work performance and user satisfaction as criteria. The uncorrelated questions were generally tasks for which no explicit functionality existed in the respondents' EMR systems (except task 15 and 19).
4. In the test-retest study, reliability was satisfactory both regarding use of and performance with the EMR system (median weighted kappa 0.718 and 0.617, respectively).
5. The VAS scaling verified the ordinality of the response choices in the "Frequency of EMR use" scale, but the scale is rather "s"-shaped than linear.

# DISCUSSION

This discussion covers the various aspects of the evaluation method presented in this thesis by moving from general to specific issues involving the task-oriented questionnaire. We are going to consider aspects of self-administered questionnaire in general, self-reporting in general, task-oriented questions in particular and finally this thesis' task-oriented questionnaire in particular. However, before starting this discussion, the key features of the questionnaire should be described.

## Key features of the questionnaire

The questionnaire is basically built up of a combination of two questions and 24 clinical tasks for physicians. In the two sections of the questionnaire; "EMR use" and "Task performance", each question is repeated with every task (Figure 4). The former asks about how often the physician uses the EMR system for a given task, and the latter about how using the system has affected the performance of the task.

(next page)

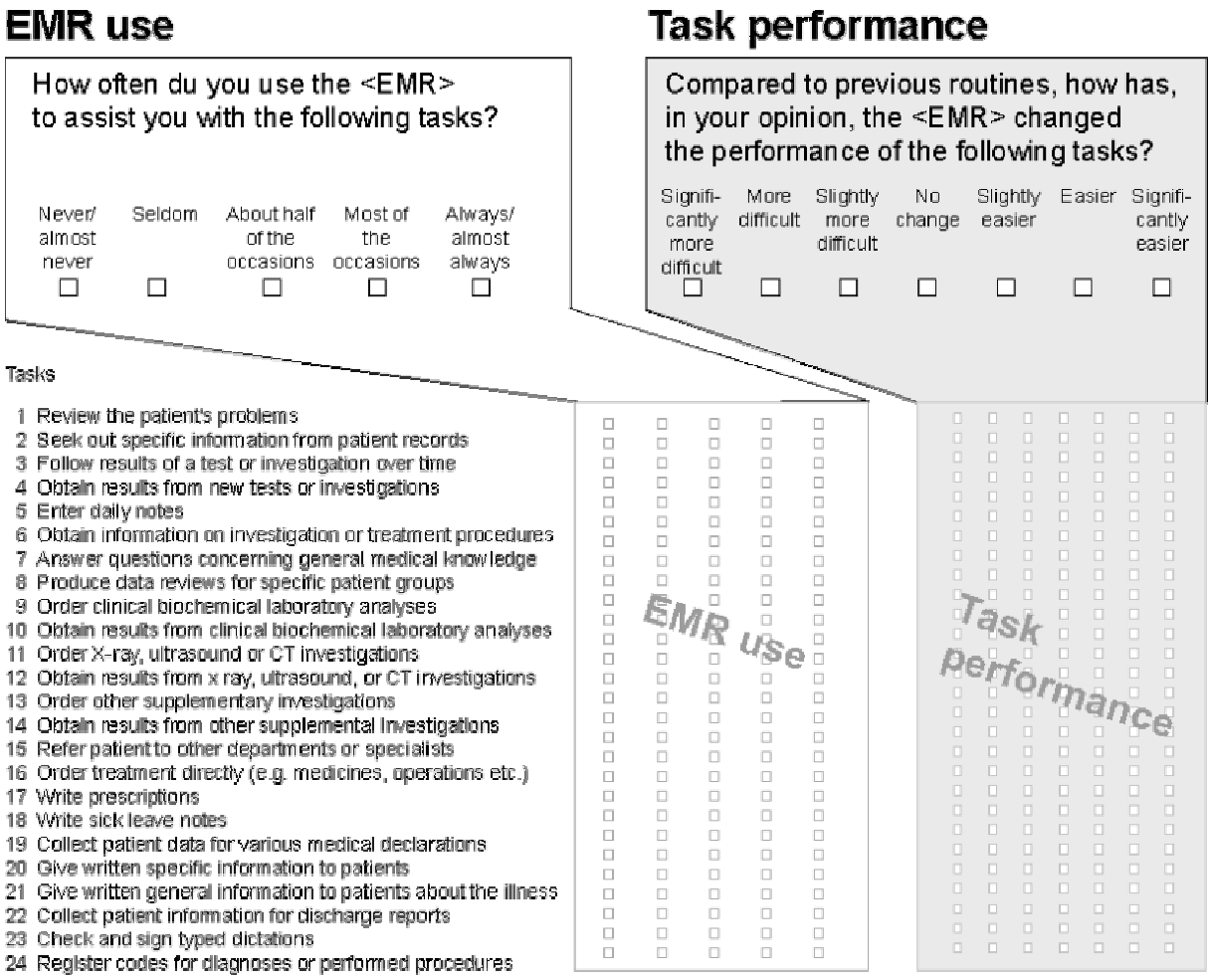



Figure 4 Diagram of the two main sections of the questionnaire. The actual questionnaire is found in appendix B, and a list of tasks including definitions and examples is found in appendix A.

*Note: In Figure 4, the escape choice ("This task is not supported by our EMR") is omitted from the EMR use section. The results from paper 4 indicated that asking for use of the EMR for tasks for which the EMR offered no explicit functionality was confusing to the respondent, despite the presence of the escape choice. Instead of relying on the escape choice, I suggest developing local versions of the questionnaire, omitting questions about unsupported tasks.*

In this questionnaire, EMR use may be interpreted in isolation. When a certain functionality in the EMR is not used, something must be wrong. Whatever reason for the lack of use, it is clear that the EMR will have minimal impact on the health care process through that particular clinical task. Other personnel may be using the functionality in question, but the effects of this use may not coincide with the initial intentions of the EMR system. For instance, when nurses use a computerized physician order entry system on behalf of the

physicians, any computer-generated messages that should result in a reconsideration of the initial order needs to be told to the physician before the order may be corrected. This results in a delayed, indirect and uncertain effect of such functionality.

| Task performance / EMR use | More difficult than before | No change | Easier than before |
|---|---|---|---|
| **High** | Worst possible: "Brute force" implementation. | Disappointing, but might be expected | Ideal |
| **Low** | A poor EMR system, ignored by the clinical staff | "The least harmful option" (careless responses might be suspected) | Task only supported in selected contexts |

Table 18 Possible interpretations of EMR use and task performance combined

When EMR use and task performance questions are combined, a whole number of interpretations is possible (Table 18). Both the ideal and worst possible combination involves a high use of the EMR. In this respect, the EMR use could be described as providing strength to the interpretation of task performance. The two questionnaire sections may be triangulated with standardized user satisfaction measures like the End User Computing Satisfaction[26] to cover the user's impression of the EMR system on the whole, completing the detailed information from the task-oriented questions.

## Advantages and disadvantages of self-administered questionnaires in general

Self-administered questionnaires are frequently used in evaluative research. I will discuss essential aspects of this method, and how the evaluation approach described in this thesis applies to these aspects.

### Representativity and response rates

Self-administered questionnaires allow an evaluator to collect large amounts of data from whole populations (or representative samples of it) using limited resources. Our studies reached 592 respondents who answered a total of 54,874 questions. However, a low response rate (number of returned and correctly completed questionnaires) may make a study's

representativity uncertain, particularly when the non-responders have something in common[76]. For instance, when a study provides a large proportion of non-responders who are extremely dissatisfied with an EMR system, or do not use the EMR system at all, a positive result from the responders may only be misleading. Therefore, a study achieving a return rate below 70% should be accompanied by follow-up study of the non-responders[77]. In our demonstration studies, the response rates were relatively high (72-93%), and except from limited distribution analyses (data not shown), follow-up of non-responders was hence not performed.

### Response bias and lack of control

In structured interviews, a standardized questionnaire helps the evaluator ask the same questions to all respondent, and immediately categorize or sort the responses. Being present as the data is collected, the interviewer may compensate for overlooked or misinterpreted questions, and hence reduce the number of missing or false responses. On one hand, a much stronger degree of response bias should be expected when the interviewer is asking the questions than when the respondent is completing the questionnaire alone[78]. On the other hand, the absence of the interviewer means that the respondent's interpretation of the questions is completely dependent on the wording and design of the questionnaire. This is the reason why validation and pre-testing is so important, and why development of questionnaires is "*not a science or technology but remains an art*"[79].

### Development and design

Designing a self-administered questionnaire means formulating questions that will be interpreted in the same way by a whole group of respondents, just by reading them. When the designer makes the questions unambiguous, it is done for respondents in cultures and contexts known to the designer. However, other cultures and contexts may incorporate very different interpretations of the questions. The solution is pre-testing the questionnaire in as similar environments as possible to that of the intended respondents, and to repeat the pre-testing when new respondent groups are added. During development of the task-oriented questionnaire, testing was done on physicians of varying specialties, varying hospitals and varying EMR systems. Its performance is however not certain among physicians whose mother tongue is not Norwegian, or in translated versions of the questionnaire. A number of

books describe general principles for good design of questionnaires. These are typically "rule of thumbs", applied incrementally in each revision as pilot tests and demonstration studies reveal flaws overlooked by the developer. The task-oriented questionnaire is in its third major revision.

## Data analysis and interpretation of results

The data produced by a questionnaire are readily analyzed and may quickly show convincing results presented as numerical scores or graphs. The simplicity and objectivity with which such data seem to provide answers may explain the popularity of questionnaires in general. The evaluator should, however, not forget that while the results produced by analysis of the responses are straightforward, the process of answering them is not.

### *Factors and scores*

In the later years, statistical research has made significant progress in quantifying and structuring underlying factors behind such ill-defined concepts as quality of life [80]. Through factor analysis and item response theory, consistent patterns have been shown in large collections of responses to questions about patients' health-related quality of life. This has been shown in spite of the inherent limitations of the ordinal scales, which are neither continuous nor equally spaced, and that of the responses, which usually don't have normal distributions. Similar work has been done on measures of user satisfaction with computers [26;68;81;82], an equally subjective concept. On the other hand, expressing subjective concepts through apparently precise numerical scores carries a risk of missing the point. The scores of a measure may reliably and validly reflect a well-defined factor of a single concept in a known context when the evaluator is knowledgeable of the essential properties of both the respondent and the measure. However, the validity of the measure quickly vanishes when the scores of independent factors are combined into one "final sum", presumably representing a heterogonous concept with a simple number. The notion of a final sum presumes that all important factors are included in the measure, and that all factors have the same importance for all people, of which neither is likely. The same considerations affect the clinical tasks defined in this thesis. It is not likely that neither their frequency nor their time consumption is equal, and their perceived importance is not expected to equal to all physicians. Further, the substantial difference between the functionality found in various EMR systems makes an overall "EMR use score" of questionable value. For these reasons, the results from the demonstration studies in this thesis have consistently been presented as individual frequency

distributions, with little or no condensation of data. (See recommendations in "presentation of results" on page 66.)

## Advantages and disadvantages of self-reporting in general

Practically all surveys using self-administered questionnaires involve self-reporting. In fact, the society is swarming with forms asking for our opinions, facts or beliefs, be it tax returns, service evaluation forms in hotels, Gallup polls or grant applications. The strengths of such forms are the instant tagging and categorization of the information, and the readiness with which otherwise inaccessible information is retrieved. There are, however, three major factors limiting the validity of the answers. First, the respondent must *understand* the question and find it applicable to her own situation. If the question is either not understood, or not found relevant, the answer will be unpredictable, if given at all. The results from paper 4 indicate that the tasks in the questionnaire are understood well by the physicians. As a second factor, the respondent must *know* the answer, which means that her memory plays an equally important role. Since humans tend to remember recent and extraordinary events more easily than distant and everyday events, respondents who are seldom using an EMR system may over-estimate their use of it ("telescoping"). Those who are not able to answer the question at all may either refrain from answering, or select the "least harmful" response label, in the middle of the scale. As a third limiting factor, the respondent must *be willing* to answer the question. Whenever the respondent risks exposing socially less desirable properties by providing honest answers to so-called threatening questions, strategic or missing responses must be expected.

In sum, missing responses may indicate lack of comprehension or applicability, too difficult or too threatening questions. In the task-oriented questions about EMR use in the demonstration studies, the proportions of missing responses were low (range 0 - 3.2%, paper 4), reducing the validity problem to "least harmful", strategic or random responses. Although a relatively high proportion of middle responses (i.e. possibly "least harmful") were found in parts of the demonstration studies (particularly the nurses' responses in paper 3), no clear patterns indicating strategic responses were found. The results were also coherent to external conditions like obliteration of the paper-based medical record (paper 2), limiting the possible proportion of random responses.

### Response effects

According to Rossi et al, response effects are the uncontrolled effects of factors not under study [76]. They argue, that for the task of transmitting information from the respondent to the interviewer, "*the characteristics of the task are the major source of response effects and are, in general, much larger than effects due to interviewer or respondent characteristics*" (page 291). In other words, the way the questions are asked is more important than the properties of the respondent.

On the general level, the method of question administration plays a role. Respondents show a greater tendency for reporting negative information about themselves with self-administered questionnaires or telephone interviews than with face-to-face interviews [83]. Provided the respondent feel that his anonymity is respected, the questionnaires appear less intimidating than interviews, and perhaps also observations.

In questionnaires, various response effects are expected by the order the question appear in, particularly affecting the questions having low saliency (i.e. not appearing as particularly important to the respondent). When more detailed questions follow general questions about the same topic, the respondents may feel that they are answering the same questions repeatedly. This is called the *redundancy effect*, and may lead to unmotivated and inaccurate answers. In our questionnaire, the detailed questions precede the general questions, reducing this effect. Further, respondents frequently show a tendency to try to be consistent, which comprises the *consistency* effect. It may serve as an aid of reconstructing answers that are difficult to remember, but it nonetheless results in later judgments being affected by the earlier ones. During the interviews described in paper 4, a variation of this effect was seen on several occasions, as the physicians corrected responses about EMR use after completing questions about task performance (unpublished data). The effect on the answers is uncertain, but keeping the order of the questions constant seems advisable. In long questionnaires, respondent *fatigue* may appear, leading to missing, perfunctory or even careless responses to the later questions. It is a good reason for keeping the questionnaires short. Our questionnaire is comprised by over 100 questions, but fatigue never the less seems to be a limited problem (Table 19, unpublished data)

| Study | Median completion time in minutes (range) | | No. of questions | Questionnaire version |
|---|---|---|---|---|
| Initial pilot tests 2000 | 9 | (4-18) | 109 | 1 |
| Interviews 2003 | 11.1 | (5.8-23.9) | 113 | 3 |

Table 19 Observed completion time of the questionnaire

Response effects also appear in the length and form of questions. On one hand, short questions are considered for a short time, thus provide a lower reporting level. On the other hand, long questions probably increase fatigue, risking the validity of the questions appearing late in the questionnaire. Questions that demand a fixed set of response alternatives are called "closed questions", and those who accept free form answer are called "open". For attitudinal questions, the level of reporting is slightly higher for open than for closed questions [84]. This suggests that providing awkward answers is easier when it is done in one's own words. Follow-up studies using open questions therefore makes sense when reduced reported task performance is expected or observed. As the act of asking questions ultimately means interacting with people, effects and factors may be described but no context-free rules [85] may be formulated.

## Advantages and disadvantages of questions about task-oriented EMR use and performance

So far, we have discussed self-administered questionnaires and self-reporting in general. Let us now consider aspects of asking about EMR use and task performance.

### Asking about EMR use and task performance may be threatening

All other things being equal, non-threatening questions are preferred to those who are threatening, due to the unpredictable nature of the latter. The task-oriented questions may be considered threatening by some respondents, despite their seemingly neutral appearance, For example, when an EMR is not used by a respondent, the EMR use questions may make him feel guilty of not using a tool paid for by tax money. Or, when the physician doesn't regard the task asked for as applicable to physicians in general, admitting a frequent use of EMR for the task may mean supporting an undesired change in work role. Indeed, the work role issue

was frequently encountered during the interviews in paper 4. Further, the results of both the national (paper 1) and local study (paper 3) showed that the reported EMR use coincided with traditional work patterns of physicians as well as nurses. This is supported by Young et al, who claim that "*doctors are unlikely to have their status increased by computer systems*"[86]. Another possible threatening element appears when the physician is not familiar with computers, and reporting a low use of an EMR system may feel as if exposing a lack of computer knowledge. However, in the national study (paper 1), a relatively high level of computer literacy was found among the physicians, and 92 % owned a PC. When responding to the questions about task performance, reporting a reduced performance and a high EMR use may suggest a possible reduction in the quality of health care. Asking questions that makes the respondent indicate that he practices bad medicine would be regarded as threatening. On the other hand, the motivation for providing feedback to the designers of less than optimal systems may be stronger. In the local study (paper 2), the physicians were strongly motivated to use the EMR system, as the paper-based medical records were obliterated. Here, a proportion of the physicians did report that certain tasks were more difficult to perform than before, and even reported that the quality of the department's work had been reduced.

### Is self-reporting of EMR use unaccountable?

Questionnaires describing self-reported usage patterns have previously been criticized for lack of precision and accountability [44;87]. However, the critics often seem to actually consider poorly validated questionnaires or too optimistic interpretations of them, rather than the very principle of self-reporting. For instance, questions that either addresses extremely complex tasks or demands a very high precision (e.g. "minutes per week") would never provide accurate answers. In a well-known validation study of the task inventory method [88], a low agreement between physicians and observers were found as well as a general over-estimation of the task frequency by the physicians. However, the task inventory had a high number of tasks (136), resulting in a high risk of respondent fatigue. Furthermore, the researchers asked for absolute task frequencies within a relatively short period (one week), making answers vulnerable to slow variations in patient characteristics, sudden interruptions of routines and changes in context. On this great level of detail, the respondent would also find it difficult to remember whether a certain task was performed this week or the preceding week. This would

particularly affect tasks with which they were very familiar, and whose performance would not grab much attention. Finally, no information was provided regarding validation on the wording of the tasks, or the reliability of the questionnaire.

Another example is found in the important UK National Health Service Information Authority's ERDIP report[56]. Here, the work of Lee et al [69] is held credit for showing that reported usage patterns do not coincide with audit trails. The discrepancy, however, was a secondary finding. Lee et al state in their discussion that "*although quick-mode was not perceived as a frequently used feature from the survey reports, actual system usage data showed that quick mode accounted for approximately 8% of all orders entered*". The self-reported usage pattern in question was based on a simple "yes/no" question about this function. With no indication of frequency, the respondents themselves had to decide what frequency of use constituted "use" or "no-use", making the interpretation of the responses uncertain. Further, no information was presented from the audit trail about who where using the quick mode function, which meant that the discrepancy could easily be explained by a very frequent use in a minority of the physicians. In addition, the questionnaire was not formally validated, and the response rate was low (56%), which makes it even more difficult to interpret the findings. In my opinion, the results from these studies do not provide convincing evidence for dismissing the validity of self-reported usage patterns.

When interpreting the results from a survey describing self-reported work patterns, the inherent limitations of self-reporting must be taken into account. Also, in even a systematically validated questionnaire, a considerable degree of bias should be expected towards answers that the respondents believe are expected from them. On the other hand, when the responses defy the implicit expectations, as shown in paper 1 and 2, the degree of bias seems to be manageable.

## Interpreting the results of task-oriented questions

### *When the physicians report that they are using the EMR system*

Frequent use of an EMR system for a certain task may be regarded a success for the part of the system designed to support the task. Indeed, it suggests that implementation is complete, and it provides a visible milestone. However, the interpretation of such results may be

complicated by a number of factors. Basically, we don't know for certain whether the EMR system is used that much or not, particularly when certain properties of the physicians under study make the questions threatening to them. Some follow-up investigations should be performed as a control of the survey. Another complicating factor is that the EMR use may vary by context in which the clinical work is performed. For instance, Norwegian physicians frequently meet patients in outpatient clinics, during ward rounds, in the wards when called for during shifts and in the emergency room when patients are admitted acutely. Some of these contexts provide a steady work environment suitable for desktop computers, and others do not. This makes distribution of work context an important confounding factor when assessing EMR use. A further complicating factor for the interpretation of EMR use is whether the physician is forced to use the system. For example, when the paper-based medical record is obliterated, as described in paper 2, the list of formal sources of patient data grows rather thin. This leaves the physician little choice but to use the system, hence other measurements like task performance or user satisfaction are needed to obtain a meaningful interpretation of the results. Furthermore, when the physician is actually using the EMR system of his own free will, he might not be using it correctly. Also, we do not know for certain whether correct use of the EMR system improves health care delivery, unless further investigations are performed. The task performance section in the questionnaire is designed to help identify problematic and beneficial areas to aid further studies.

### *When the physicians report that they are not using the EMR system*

When the physicians report that they are not using an EMR system for a certain task, the clinical impact of the EMR system for this task is doubtful. However, the reasons for the lack of use may be numerous[89]. First, *usability* may be an issue, when the EMR system is too cumbersome to use or too difficult to learn[62]. Second, lack of *usefulness* may be a problem. The functionality in the EMR system may not really be useful compared to existing routines, i.e. it is not making clinical work easier for the physician. For example, the process of navigating, searching, selecting, editing and printing a prescription using the computer is not necessarily easier than writing a short prescription by hand. As a third reason, a low a*vailability* of computers may prevent the physician from using them. The computers may for instance not be present where clinical decisions are being made, e.g. on rounds. Fourth, a *fear of control* may deter the physicians. When using the EMR system, several clinical activities may more easily be audited by the hospital administration, and this may threaten the

physician's traditional autonomous position. Fifth, *work role issues* may make the physicians refrain from performing tasks that are supported by the EMR system, but not regarded as part of their work. Sixth, a *lack of ownership* may occur, for instance in top-down implementations (i.e. with little involvement of the users). Here, the physicians may perceive the EMR system as an external object not relevant to them, and they will therefore not relate to it at all. Seventh, the *attitudes to computers in general* may play a role. The physicians who view the application of computers to medicine as desirable tend to utilize it to a greater extent in their practice [90]. Eighth, the *computer experience* may be too limited. Physicians who are not experienced with computers will find learning to use them a greater challenge than those who are, and hence use them for less tasks. Ninth and final, we have *fear of disruption of physician-patient relationship*: Some physicians feel that using computers shifts their role from healer to technical expert. It thereby replaces the medical arts with health sciences and ultimately increases the social distance between patient and physician. Again, the way to sort out the reasons for lack of use is by performing further studies, preferably using one of the several hypothesis-generating qualitative methods.

### Comparing EMR use and task performance to user satisfaction

Although self-administered questionnaires is a common method for evaluating EMR systems, task-oriented EMR use and task performance is not the most common perspective of such questionnaires. In properly validated questionnaires, user satisfaction is a far more common perspective, for example in "QUIS" by Garrett and Slaughter [68], "SUMI" by Kirakowski [82], "EUCS" by Doll & Torkzadeh [91] and "SGUS" by Aydin & Rice [65;92] The inherent importance of user satisfaction by itself and its relevance to usability of EMR systems [69] is well documented and widely accepted. However, one should not depend on it alone. For example, the apparently self-contradictory combination of high user satisfaction and low EMR use is possible, as seen in the national study (paper 1). This suggest that low expectations of the real usefulness of EMR systems plays a role in answering such questions, or perhaps that a certain modesty towards demanding expensive equipment for assisting one's own "paper work" is prevalent. Further, as found in the interviews in paper 4, it is difficult for the user to decide whether to provide answers based on the functionality actually available in the EMR system, or on the functionality that should have been in the system. This in particular affects the global user satisfaction questions, e.g. "*All considered, how would you rate the success of the*

*EMR system in your department?*" Despite these limitations, the EUCS and SGUS user satisfaction measures have been incorporated in separate sections in the questionnaire, providing useful references for interpretation of the other sections.

## Advantages and disadvantages of this questionnaire

In this discussion, we are moving from general to specific issues regarding the task-oriented questionnaire. It is time to consider aspects that are specific to this questionnaire only.

### The development of the questionnaire

The task list in our questionnaire is based on 45 h of observations of clinical activities during three separate observational studies in two hospitals, of which 7h was transcribed and 4.5 h was videotaped (paper 4). The questionnaire has been validated in interview studies and by criterion questions in the demonstration studies. The latter also provided information on its performance, both in a single hospital (paper 2) and nationally (paper 1). Variations of the questionnaire have been developed for nurses and medical secretaries (paper 3), but not as comprehensively as that of the original. All three studies did, however, provide interesting results.

### What have we already found using the questionnaire?

Using the questionnaire, we have already gained knowledge about the EMR systems in Norway. In the national study, we learnt that current EMR systems are incomplete both in terms of functionality and content. Perhaps more importantly, the actual implemented functionality was frequently *not* used by the physicians. The reasons are not known (see discussion in paper 1), but the results clearly indicate that the EMR systems are not yet fulfilling their purpose. In the local study, we learnt that replacing the paper-based medical record with an EMR system is feasible using scanning technology, but at a price in terms of reduced task performance reported by almost half of the internists (paper 2). In this study, the medical secretaries were more satisfied with the EMR system than the nurses and the physicians, were using it more extensively and reported the highest increase in task performance (paper 3). The results of these demonstration studies indicate that the task-oriented questionnaire is a useful tool, also when comparing it to other questionnaires.

### Comparing the task list in the questionnaire to other published task lists

The task-oriented questionnaire builds upon task analysis. This is a well-known technique for describing in detail how various work is performed [71], providing over 40 different ways of producing task lists (i.e. task inventories). The literature contains a number of studies involving task lists and task analysis techniques[13;61;88;93-97], but none of them provides a general task list, applicable to various specialties, hospitals and EMR systems. The task list described in this thesis is designed to fill that void. For example, when comparing its 24 tasks to the 400-600 tasks commonly found in full task inventories [98], the number of tasks appears moderate. The high response rates suggest that the resulting number of questions is manageable to the respondents. Compared to that of similar questionnaires [69;99], the task list provides the evaluator with more details about areas for improvement, and it is not designed with one particular EMR system in mind [69]. In addition, more emphasis is placed on clinical use of the EMR system, since the tasks are limited to information-related instead of both practical and information-related tasks [100], and to clinical instead of both clinical and academic work [99]

### Limitations of the questionnaire

The questionnaire is not validated by system audit trails and only to a limited degree by observations. Performing a validation study comparing self-reported use to that of observed EMR use will however be a challenging task, as a number of physicians and contexts need to be investigated, and the external interpretation of what the physicians actually do must undergo evaluation as rigorous as that of a questionnaire. This remains a research subject to be pursued. Further, the questionnaire does not cover communication between health personnel, which is integral to the flow of clinical information in hospitals. Again, this is a challenging subject deemed too comprehensive for inclusion in this thesis. Finally, the task inventory used in the questionnaire is comprehensive, but not necessarily complete. This is one of the reasons for presenting the results in detailed manner, clearly showing what the evaluation covers and what it does not. Instead of calculating a potentially misleading sum score, the activities of the physicians are represented individually, provides the evaluator with a map that may guide her further efforts.

### Other uses for the task list in the questionnaire

The task list may be utilized for other purposes than self-reporting and interviews. It may for instance provide the basis for development of detailed test suites in usability studies [62]. Here, the test person is asked to solve a suite of detailed tasks on a given EMR system. This suite of tasks should be manageable but representative, making the task list in this thesis a fair choice. A further use of the task list is that various systems may be compared in terms of completeness of functionality using it. This was done in our national study, providing an instant review (paper 1) of the level of functionality in our current EMR systems. Finally, the task list may be used as a basis for requesting and filtering system audit trails, helping researcher reduce the immense amount of information frequently found in such studies.

# CONCLUSION AND RECOMMENDATIONS

## Where does the method fit in?

The questionnaire may be used as an objectivist, summative part of any EMR evaluation involving the clinical work of physicians. The questionnaire should be applied in the phases following implementation, i.e. as operational reviews in maintenance and evolution phases (Figure 3 on page 34) Baseline studies are preferred, for instance preceding major updates of an EMR system, but this is not imperative. When considering the dimensions provided by various authors, the questionnaire fits with the "User performance and satisfaction" dimension by Eason, the "Efficiency", the "Organizational" dimension by Westbrook & Gosling, the "Human" and "Operational" dimensions by ERDIP, and questions 2-4 and 8 by Anderson & Aydin (Figure 5).

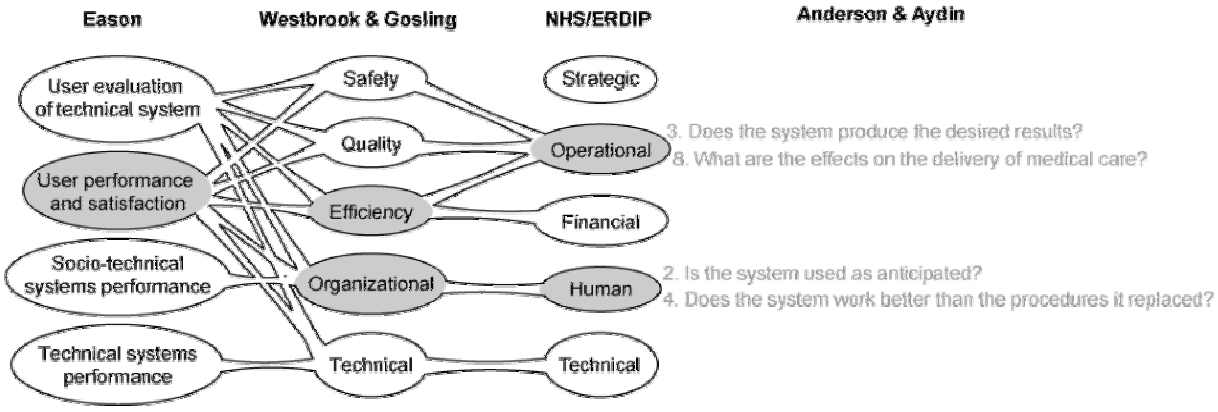



Figure 5 Dimensions of EMR evaluation. The dimensions involved by the questionnaire have a grey background. In the Anderson & Aydin column, only relevant questions are shown.

As shown on Figure 5, the questionnaire only covers selected parts of the dimensions described by the various authors, which further emphasizes that the questionnaire should not be used in isolation. The method is developed for hospitalists, but may also be applied to primary care physicians. In March 2003, it was successfully applied in a survey among primary care physicians, achieving a response rate of 71% (240/344 physicians, Christensen & Lærum 2003, unpublished data)

### The questionnaire may focus the evaluation effort

The questionnaire may be used as an evaluation tool in combination with other methods, but the task list contained in it may also be utilized for focusing the evaluation effort.

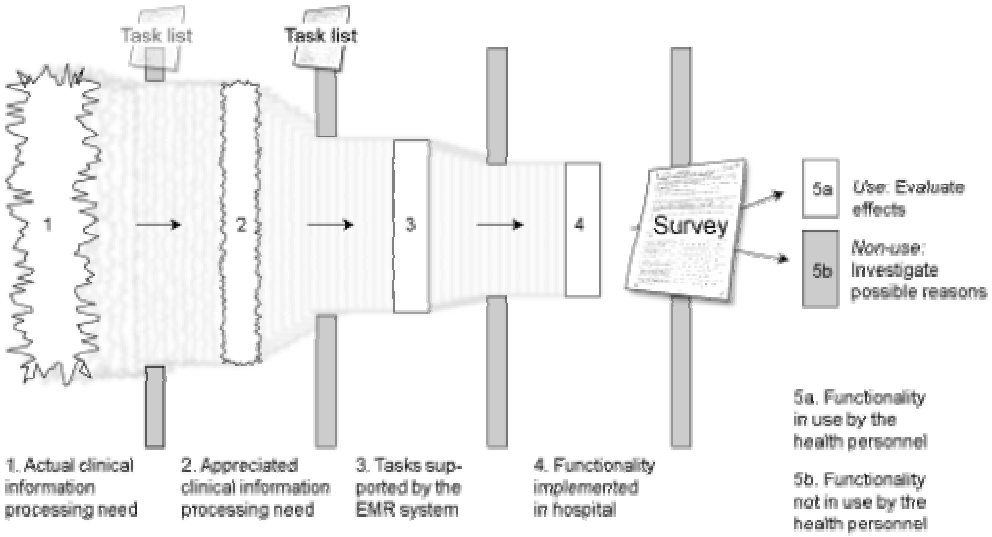



Figure 6 Focusing of EMR evaluations.

In Figure 6, the total information processing need during diagnostics, treatment and follow-up appears on the far left (part 1). It represents recognized, unrecognized and pursued information needs[27] of physicians, as well as the need for documentation. This is an undefined quantity that by the act of definition is transformed into the appreciated information processing need (part 2). When an EMR system is chosen, this need is transformed into a list of clinical tasks supported by the system, according to the vendor (part 3). The list of support tasks is further reduced when the system is actually implemented in the given hospital (part 4). The latter is due to the fact that technical and organizational issues like lack of available computers and low department readiness are prone to cause postponements in implementation of selected functionality. On the far right of the figure, the survey is performed. In the process, the functionality list is split into two groups, containing those who are reportedly used by the respondents (part 5a), and those who are not (part 5b). Each group of functionality elicits different approaches of follow-up studies, as shown in the discussion. The functionality list (as well as the accompanying areas of clinical activity affected by the system) is now

considerably reduced. This makes selection of evaluation criteria for the effect of the EMR system easier. Furthermore, the discrepancy between the information processing need in part 2 and the actual functionality in use in part 5a should illustrate how the EMR system supports actual clinical work.

## Recommendations for future EMR evaluations

I suggest that the questionnaire is considered for any EMR evaluation project involving the physician's clinical perspective, with the described advantages and disadvantages of the method taken into account. The application of the questionnaire should include three phases: initial exploration of EMR and hospital, survey and post-survey qualitative study.

### 1. Initial exploration – describing the hospital and the EMR in detail

Before performing a survey, the hospital(s) under study must be described in sufficient detail not only for the logistic aspects of the investigation (e.g., names and addresses of physicians, departments and heads of departments), but also to understand how the institution is delivering health care (e.g. size of hospital, academic versus community practice, type of departments, outpatient versus inpatient services, etc.). The live, implemented EMR must be described, and questions not supported by it should be omitted from the questionnaire. The generic "EMR" term in the questionnaire should be replaced with the actual name of the EMR system, as the respondents will recognize the latter more easily.

### 2. Survey – measuring self-reported EMR use, task performance and user satisfaction

The respondents should be notified one week in advance of the survey, in a short, personal letter describing the intentions of the study. Clear support from the hospital administration should be expressed in this letter. To achieve adequate control of how the survey is carried out, printing, distribution and collection of questionnaires should be centralized, i.e. handled by only one or two persons. This work is greatly simplified when using a database for

managing all stages of the survey. At least one reminder including a new copy of the questionnaire should be sent to non-responders. The timing of the reminder is readily identified by plotting the number of responses incrementally on a time scale. The point where the plot slope is leveling off is the ideal time for distributing a reminder. Further advice on managing surveys is found in the literature [77;101;102].

### *Analysis of data*

The data in the task-oriented questions on EMR use and task performance is not intended to be summed. Rather, the distribution of the responses of each question should be plotted separately, as shown in Figure 8 on page 20. Differences in each question between various groups are found by non-parametric statistical tests like Mann-Whitney U (two groups) and Kurskall-Wallis (more than two groups). Correlations are calculated by Spearman's rho. Confidence intervals of individual response proportions are calculated using the following formula [103]:

$$p \pm 1.96 \times \sqrt{\frac{p(1-p)}{n}}$$

Figure 7 Confidence interval of a proportion, in which p equals the propotion and n equals the sample size.

The evaluator should be mindful of the attenuation of real differences in task-oriented questions for which the test-retest reliability is low (tasks 7, 9 and 13, see paper 4), particularly in small samples (e.g. below 100).

### *Presentation of results*

The data from the survey should be presented as plain frequency distributions. However, the resulting graphs or tables may easily become overly complex, and the reader might not understand them. To make the graphs understandable, special graphics techniques need to be utilized. I have chosen multiple horizontal bar graphs, as they unambiguously show proportions of the responses to each question. In line with the incremental nature of the scales used in the questionnaire, the individual response choices are assigned colors on a gradient, corresponding to their assigned meaning. In this case, red is representing responses deemed unfortunate for the intention of the EMR ("bad"), and blue is representing responses deemed fortunate("good"). This way, overall patterns of responses are clearly communicated without

hiding any data (Figure 8). In addition, the format allows presentation of one set of errors bars, to indicate the degree of uncertainty of the proportion estimates.

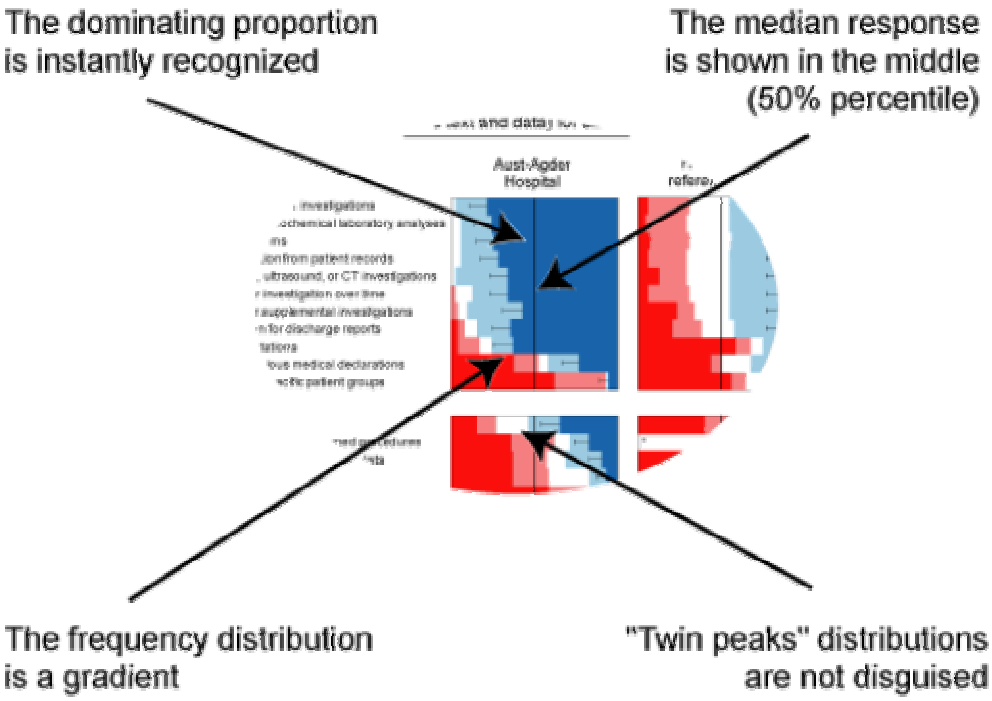



Figure 8 Elements of graphs representing task-oriented responses

### 3. Post-survey qualitative study – looking for answers to the findings in the survey

After analyzing the survey, a qualitative study should be performed. This may provide answers and hypotheses for the results from the survey, and even demonstrate phenomena completely missed by the questionnaire. One possible method for a qualitative study would be open-ended interviews of at least one representative (physician) from each department or hospital in study. For further information on qualitative methods, see Ringdal[104].

# APPENDICES

## Appendix A - Task list with definitions and examples

This appendix contains a list of the 24 tasks as they appear in the third revision of the questionnaire, including individual definitions and examples.

| No | Task | Definition | Examples |
|---|---|---|---|
| 1 | Review the patient's problems | Gather enough existing information to formulate the patient's main problem(s), in order to perform or order new investigations or make a clinical decision. | 1) Assess the patient's history during consultation; 2) "jog the memory" during rounds. |
| 2 | Seek out specific information from patient records | Seek out a specified, limited amount of information about the patient in the patient records | 1) Find out what blood pressure the patient had five years ago; 2) identify the type of pacemaker used by the patient; 3) seek out the last measured creatinine level; 4) find out what antibiotics the patient actually was taking during a reported spell of allergy-like symptoms three years ago. |
| 3 | Follow the results of a test or investigation over time | Get the result of at least to identical investigations performed at different points of time, in order to assess the development of the underlying patterns of disease. | 1) Assess how quickly the systolic murmur has changed; 2) identify a suspicious decline in hemoglobin concentration following surgery. |
| 4 | Obtain the results from new tests or investigations | Identify and gather results from performed and analyzed investigations not yet assessed by a physician. | Gather the latest lab printout sheet for a patient during rounds. |
| 5 | Enter daily notes | Personally type or write updated assessments of the patient's condition like progress notes. | Type a progress note for a patient describing decrease in CRP and improved general condition. |
| 6 | Obtain information on investigation or treatment procedures | Gather information about the hospital's consensus about how a certain investigation or treatment procedure should be performed. | Look up a treatment of diabetic ketoacidosis in the Hospital's paper-based collection of endorsed procedures. |
| 7 | Answer questions concerning general medical knowledge (e.g.concerning treatment, symptoms, complications etc.) | Gather information answering general medical questions about investigation or treatment of a certain condition. | 1) Look up in a medical text book about COPD; 2) Ask an experienced colleague about prognosis of COPD. |
| 8 | Produce data reviews for specific patient groups, e.g. complication rate, distribution of diagnoses. | Gather or produce data reviews of a certain patient group relevant to the physican's own work. | 1) Gather the frequency of certain diagnoses in the local population; 2) compare it to that of the general population. |
| 9 | Order clinical biochemical laboratory analyses | Order one or several clinical biochemical laboratory analyses. The booking of the test may be performed by the physician or other personnel. | 1) Tell the nurse to order C-reactive protein and white blood cell count; 2) order white blood cell count by using the computerized physician order entry module in the EMR system. |
| 10 | Obtain the results from clinical biochemical laboratory analyses | Obtain any results of clinical biochemical laboratory analyses, new and old. | Look in the lab printout sheet for the latest hemoglobin concentration measured before surgery. |

| | | | |
|---|---|---|---|
| 11 | Order X-ray, ultrasound or CT investigations | Decide upon and order an X-ray, ultrasound or CT investigation, including providing a clinical summary of the patient if required. The booking of the investigation may be performed by the physician or other personnel. | Order X-ray of the thorax by filling in an investigation form by hand, describing symptoms suggesting pneumonia in the lower left lung. |
| 12 | Obtain the results from X-ray, ultrasound, or CT investigations | Obtain any results of X-ray, ultrasound, or computer tomography investigations, new and old. | Gather the results of a previous abdominal CT scan by searching for the results sheet in the patient record |
| 13 | Order other supplementary investigations | Order supplementary investigations other than clinical biochemical lab tests, X-ray, ultrasound or CT investigation. The booking of the investigation may be performed by the physician or other personnel. | 1) Personally order scintigraphy through the order entry system in the EMR; 2) order a microbiological investigation of specimen from a punctured abscess by completing a form. |
| 14 | Obtain the results from other supplemental investigations | Obtain any results of laboratory analyses other than clinical biochemical lab tests, X-ray, ultrasound and computer tomography, new and old. | Look up the results of a scintigraphy in the EMR system. |
| 15 | Refer the patient to other departments or specialists | Inquire an assessment by a specialist, leading to advice on further follow-up or transfer to another department. The task includes provision of a clinical summary and the purpose of the referal. | Fill in and send a referral form for an endocrinologist's advice on a patient suffering from a fractured hip and poorly managed diabetes. |
| 16 | Order treatment directly (e.g. medicines, operations etc.) | Order treatment (medication, surgery, other) to be performed on the hospital, usually not administered by the patient. Writing a prescription is not included in this task. | 1) Order aorto-coronar bypass surgery by filling out a form by hand and contacting the head nurse in surgery unit; 2) order peroral anticoagulant medication by writing in the medication list on a continuous medical treatment form during rounds. |
| 17 | Write prescriptions | Order medications (or other types of self-administered treatment) for the patient (or a representative) to buy, collect and administer. The order must include instructions for the patient about how and when the treatment should be applied. | Write a prescription of erythromycin against sinusitis by hand, and give it to the patient. |
| 18 | Complete sick-leave forms | Produce standarized recommendation of sick leave, including required clinical information, usually by filling in a form. | Fill in a sick leave form by hand, recommending a week sick leave due to a sprained ankle. |
| 19 | Collect patient data for various medical declarations | Gather enough clinical information about the patient to produce a valid medical declaration. | Collect information to provide a declaration about the patien't ability to work after the convalescence from a traffic accident is complete. |
| 20 | Give written individual information to patients (such as medication lists, status of the disease, etc) | Provide the patient with written clinical information about the patient's condition relevant for continuing care. | Provide the patient with an updated medication list and a summary of the hospital stay upon discharge |
| 21 | Give written general information to patients about the illness | Provide the patient with written information about the patient's condition in general; its cause, prognosis and treatment. | Give a leaflet to the patient describing heart failure in general, its causes, prognosis and treatment |
| 22 | Collect patient information for discharge reports | Gather enough information to generate a discharge report, including a summary of the hospital stay, current medications or other treatment and planned follow-up. | Gather the patient record and all lab sheets, read, sort and spread out the relevant papers on a table before dictating the discharge report. |
| 23 | Check and sign typed dictations | Verify that the contents of transcribed dictations are correct, and sign it. | Check and sign a printed discharge note. |
| 24 | Register codes for diagnoses or performed procedures | Perform selection(s) from various classification system for performed clinical procedures or current diagnoses, and document the selections. | Look up in a classification book, and dictate a relevant code for the performed surgery at the end of the surgery report. |

## Appendix B - The questionnaire and its revisions

This appendix contains the questionnaire in its three revisions, both in Norwegian (original) and English (translated).

# Revision 1, Norwegian (National Study 2001)

**4006579247** Kvalis EPJ Evalueringsskjema
Hallvard L□rum (tlf. 73869748) og Gunnar Ellingsen (tlf. 77626121) IDnr ☐☐☐☐

**A. Alder, kjłnn og klinisk stilling**

| Alder | Kjłnn | Klinisk Stilling |
|---|---|---|
| ☐ <35 | ☐ Kvinne | ☐ Turnuslege |
| ☐ 35-50 | ☐ Mann | ☐ Assistentlege |
| ☐ >50 | | ☐ Overlege |

*Kryss av slik:* ☒
*Ikke slik:* ☐

**B. Om din erfaring med bruk av datamaskin**

| | | Ja | Nei |
|---|---|---|---|
| 1 | Eier du en datamaskin? | ☐ | ☐ |
| 2 | Hvor mange fingre bruker du n□r du skriver p□ maskin? | ☐ To ☐ Tre eller flere ☐ Alle (evt. touch) | |
| 3 | Har du brukt en datamaskin til | Ja | Nei |
| | a ¯ lete etter et labresultat eller svar p□ andre supplerende undersłkelser? | ☐ | ☐ |
| | b Litteratursłk | ☐ | ☐ |
| | c Tekstbehandling | ☐ | ☐ |
| | d Skrive inn kliniske pasientopplysninger (eks. et poliklinisk notat) | ☐ | ☐ |
| | e Innhente kliniske pasientopplysninger (eks. en tidligere epikrise) | ☐ | ☐ |
| 4 | Har du noen gang tatt et datakurs? | ☐ | ☐ |
| 5 | Kan du programmere? | ☐ | ☐ |

| | | Aldri | Sjelden | M□nedlig | Ukentlig | Daglig |
|---|---|---|---|---|---|---|
| 6 | Hva er den hłyeste hyppigheten du har brukt datamaskin tidligere? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Lavest | | Middels | | Hłyest |
|---|---|---|---|---|---|---|
| 7 | Hvordan vil du rangere dine dataferdigheter? | ☐ | ☐ | ☐ | ☐ | ☐ |

**C. Om tilgjengelighet av datamaskiner p□ din arbeidsplass p□ sykehuse**

| | | Ja | Nei |
|---|---|---|---|
| 1 | Har du en datamaskin p□ kontoret ditt? (svar nei hvis du ikke har kontorplass) | ☐ | ☐ |
| 2 | Vedrłrende łvrige rom du benytter ved klinisk arbeid (eks. sengepost, poliklinikk, undersłkelsesrom): | | |
| | a Finnes det datamaskiner som er tilgjengelig for deg her? | ☐ | ☐ |
| | b Hvis ja, bruker du denne eller disse datamaskinen(e)? | ☐ | ☐ |

*Hvis du svarte nei p□ b□de spłrsm□l 1 og 2a, trenger du ikke fylle ut resten av skjemaet*

3 Ang□ende datamaskinen(e) som er installert p□sengepost, poliklinikk, undersłkelsesrom, o.l.:

| | | Aldri | Sjelden | M□nedlig | Ukentlig | Daglig |
|---|---|---|---|---|---|---|
| a | Hvor ofte hindres du i □ bruke datamaskin fordi den er i bruk av andre? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b | Hvor ofte hindres du i □ gjłre det du skal pga. datafeil, glemt passord eller andre maskinavhengige problemer? | ☐ | ☐ | ☐ | ☐ | ☐ |

**D. Om ditt bruk av datamaskin (PC) til arbeidsoppgaver innen klinisk arbeid p□ sykehuset**

| Hvor ofte bruker du datamaskin (PC) til □ hjelpe deg med flgende arbeidsoppgave: | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden [1] | Som regel | Alltid/ nesten alltid | Hvilke(t) dataprogram bruker du evt. til denne arbeidsoppgaven? Bruker EPJ [2] | Bruker annet dataprogram enn EPJ |
|---|---|---|---|---|---|---|---|
| 1 F□ oversikt over pasientens problemstilling | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Lete frem enkeltopplysninger fra pasientjournalen | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Flge resultatene av en bestemt prve eller undersøkelse over tid | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Sl□ opp svar p□ nye prver eller undersøkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Fre daglige og/eller forefallende journalnotater | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 F□ tak i opplysninger om prosedyre for utredning eller behandling | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 F□ svar p□ spørsm□l om generell medisinsk-faglig kunnskap, eks. vedr. behandling, symptomer, komplikasjoner, o.l. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 F□ ut samledata for en gruppe pasienter, eks. komplikasjonsrate, diagnosefordeling | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 Rekvirere klinisk-kjemiske laboratorieanalyser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 Sl□ opp svar p□ klinisk-kjemiske lab.-analyser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 Rekvirere rntgenundersøkelser, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 Sl□ opp svar p□ rntgen, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 Rekvirere andre supplerende undersøkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 Sl□ opp svar p□ andre suppl. undersøkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 Henvise pasienten til annen avdeling eller spesialist | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 Ordinere behandling direkte (medikamentell, operativ eller annen) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 Skrive resept | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 Skrive sykmelding | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 Samle inn pasientopplysninger til ulike lege-erkl□ringer (eks. ufrepensjon) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 Gi skriftlig individuell informasjon til pasienten (eks. sykdommens status, medikamenter, m.m.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 Gi skriftlig generell medisinsk-faglig informasjon til pasienten | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 Samle inn opplysninger til epikrise | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 Kontrollere og signere ferdig skrevne diktater | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

24 Annet (spesifiser)

[1] Tiden man bruker p□ denne arbeidsoppgaven

**Husk □ fylle ut kolonnen til hyre ogs□....**

[2] DocuLive, DIPS eller Infomedix

**E. Om foretrukket informasjonskilde**

N□r du arbeider med diagnostikk og behandling:

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Hvor ofte bruker du andre informasjonskilder enn EPJ[1] eller papirjournalen/kurven? | ☐ | ☐ | ☐ | ☐ | ☐ |

*Vi regner her papiret henvisningen er skrevet p□ som en del av papirjournalen. Andre informasjonskilder kan v□re avdelingsvise skyggearkiv og egne dataprogrammer, llse lapper utenfor papirjournalen, annet helsepersonell, prim□rlege (via telefon), m.m.*

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tilfellene | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 2 Hvor ofte er EPJ[1] det flrste du henvender deg til hvis du har papirjournalen tilgjengelig og... | | | | | |
| a ...du kjenner pasienten fra flr av? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b ...du ikke har sett pasienten flr? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tilfellene | Som regel | Alltid/ nesten alltid | Ikke aktuell problemst |
|---|---|---|---|---|---|---|
| 3 Hvis du stort sett bruker EPJ flrst: | | | | | | |
| a Hvor ofte m□ du i tillegg se i papirjournalen eller bruke andre informasjonskilder? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

*G□ videre til seksjon F hvis du svarte "Aldri/nesten aldri" eller "Sjelden"*

| | | | | | | |
|---|---|---|---|---|---|---|
| b Hvor ofte skyldes dette at du łnsker □ dobbeltsjekke opplysningene? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c Hvor ofte skyldes dette at du ikke finner informasjonen du łnsker i EPJ? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**F. Om din oppfatning av den elektroniske pasientjournalen (EPJ [1]) som finnes p□ din avdeling**

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Innhold | | | | | |
| a Hvor ofte gir systemet deg akkurat den informasjonen du trenger? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonsinnholdet nok for ditt behov? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c Hvor ofte klarer systemet □ lage rapporter som ser ut til □ passe akkurat for deg? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d Hvor ofte gir systemet tilstrekkelig informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Nłyaktighet [2] | | | | | |
| a Hvor ofte er systemet nłyaktig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er du fornłyd med nłyaktigheten i systemet? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Format | | | | | |
| a Hvor ofte synes du svarene fra systemet presenteres p□ en nyttig m□te? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonen klar og tydelig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Brukervennlighet | | | | | |
| a Hvor ofte er systemet brukervennlig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er systemet enkelt □ bruke? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Betimelighet | | | | | |
| a Hvor ofte f□r du den informasjonen du trenger i tide? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte gir systemet deg oppdatert informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] DocuLive, DIPS eller Infomedix

[2] Eks. At rett journal, rett pasient og rett dokumenttype finnes frem; at informasjonen (eks. blodtrykk) presenteres med rett navn; at informasjonen som presenteres er relevant; at samledata i rapporter er korrekte, m.m.

[3] Tiden man bruker med datasystemet

**C. Samlet vurdering av den elektroniske pasientjournalen (EPJ) ved din avdeling**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 Hvor enig eller uenig er du i fllgende utsagn: | Sv□rt uenig | Uenig | Litt uenig | B□de og | Litt enig | Enig | Sv□rt enig |
| EPJ er verdt den tid og de krefter det tar □ bruke det | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| | Ikke i det hele tatt | Lite | Noe | Godt | Sv□rt godt |
| 2 Alt i alt, hvor fornłyd er du med den EPJ du bruker p□ din avdeling/seksjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

3 Alt i alt, hvordan synes du EPJ har endret fllgende to aspekter ved <u>din egen</u> avdeling eller seksjon:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen endring | Litt lettere | Lettere | Betydelig lettere |
| a Gjennomflringen av arbeidet ved v□r avdeling/seksjon er blitt: | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | Betydelig d□rligere | D□rligere | Litt d□rligere | Ingen endring | Litt bedre | Bedre | Betydelig bedre |
| b Kvaliteten p□ arbeidet ved v□r avdelingen/seksjon er blitt: | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| | Ikke i det hele tatt | Lite | Noe | Godt | Sv□rt godt |
| 4 Hvor vellykket er den EPJ du bruker ved din avdeling/seksjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

**H. Eventuelle kommentarer**

Eks. Var deler av splrreskjemaet uklart eller tvetydig?

## Revision 1, English translated version

This is an English translated version of the questionnaire used in the national study in 2001.

**A. Age, gender and work position**

| Age | Gender | Work position |
|---|---|---|
| ☐ <35 | ☐ Female | ☐ Intern |
| ☐ 35-50 | ☐ Male | ☐ Resident |
| ☐ >50 | | ☐ Consulting physician |

*Check like this:* ☒

*not like this:* ☒

**B. About your experience with computers**

| | | Yes | No |
|---|---|---|---|
| 1 | Do you own a computer? | ☐ | ☐ |
| 2 | How many fingers do you use when typing? ☐ Two ☐ Three or more ☐ All (or touch) | | |
| 3 | Have you used a computer for: | Yes | No |
| | a Test result retrieval | ☐ | ☐ |
| | b Literature search | ☐ | ☐ |
| | c Word processing | ☐ | ☐ |
| | d Entering patient info | ☐ | ☐ |
| | e Retrieving patient info | ☐ | ☐ |
| 4 | Have you ever taken a computer course? | ☐ | ☐ |
| 5 | Can you write computer programs? | ☐ | ☐ |

| | | Never | Rarely | Monthly | Weekly | Daily |
|---|---|---|---|---|---|---|
| 6 | In the past, what is the most frequent you used a computer? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Lowest | | Average | | Highest |
|---|---|---|---|---|---|---|
| 7 | How would you rate your computer skills? | ☐ | ☐ | ☐ | ☐ | ☐ |

**C. About the availability of computers at your working place at the hospital**

| | | Yes | No |
|---|---|---|---|
| 1 | Do you have a computer in your office (answer no if you haven't got any office) | ☐ | ☐ |
| 2 | Concerning other rooms you use for clinical work (e.g. ward, outpatient clinic offices, investigation rooms) | | |
| | a Are there computers available for you here? | ☐ | ☐ |
| | b If yes, do you use these computers? | ☐ | ☐ |

*If you responded "no" to both questions 1 and 2a, you don't have to fill out the rest of the questionnaire*

3 About the computers installed in the ward, at the outpatient clinic offices, investigation rooms, etc.

| | | Never | Rarely | Montly | Weekly | Daily |
|---|---|---|---|---|---|---|
| a | How often are you prevented from using them because others are using them? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b | How often are you prevented from using them due to computer errors, forgotten passwords or other machine-related problems? | ☐ | ☐ | ☐ | ☐ | ☐ |

**D. About your use of personal computers for clinical tasks in the hospital**

| How often do you use a personal computer (PC) to assist you with the following tasks: | Never/ almost never | Seldom | About half of thetime [1] | Most of the time | Always/ almost always | What computer program do you use for this task? EMR[2] | Other than EMR |
|---|---|---|---|---|---|---|---|
| 1 Review the patient□s problems | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Seek out specific information from patient records | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Follow the results of a particular test or investigation over time | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Obtain the results from new tests or investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Enter daily notes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 Obtain information on investigation or treatment procedures | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 Answer questions concerning general medical knowledge (e.g. concerning treatment, symptoms, complications etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 Produce data reviews for specific patient groups, e.g. complication rate, diagnoses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 Order clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 Obtain the results from clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 Order X-ray, ultrasound or CT investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 Obtain the results from X-ray, ultrasound or CT investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 Order other supplementary investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 Obtain the results from other supplementary investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 Refer the patient to other departments or specialists | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 Order treatment directly (e.g. medicines, operations etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 Write prescriptions | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 Write sick-leave notes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 Collect patient information for various medical declarations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 Give written individual information to patients, e.g. about medications, disesase status | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 Give written general medical information to patients | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 Collect patient info for discharge reports | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 Check and sign typed dictations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

24 Other (specify)

[1] The time normally spent on this task

[2] DocuLive, DIPS or Infomedix

**Remember to fill in this column, too....**

**E. About choice of information source**

When working with diagnostics and treatment:

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 1 How often do you use other sources of information than the EMR or the paper journal/patient chart? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 2 How often is EMR[1] the first you'll turn to if the paper journal is available and… | | | | | |
| a …you know the patient? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b …you have never seen the patient before? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always | Not applicable |
|---|---|---|---|---|---|---|
| 3 If you usually turn to the EMR first: | | | | | | |
| a How often do you have to consult the paper journal or use other information sources? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| *Go to section F if your response was "Never/Almost never" or "Seldom"* | | | | | | |
| b How often did you do this because you wanted to verify the content of the information? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c How often did you do this because you didn't find the information you wanted in the EMR? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**F. About your satisfaction with the EMR[1] installed in your department**

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 1 Content | | | | | |
| a How often does the system provide the precise information you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the information content meet your needs? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c How often does the system provide reports that seem to be just about exactly what you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d How often does the system provide sufficient information? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Accuracy [2] | | | | | |
| a How often is the system accurate? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often are you satisfied with the accuracy of the system? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Format | | | | | |
| a How often do you think the output is presented in a useful format? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the information clear? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Ease of use | | | | | |
| a How often is the system user-friendly? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the system easy to use? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Timeliness | | | | | |
| a How often do you get the information you need in time? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the system provide up-to-date information? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] DocuLive, DIPS or Infomedix

[2] E.g. right journal, right patient and right document types is located; the information (e.g. blood pressure) is labelled correctly, that the information presented is relevant; the aggregated data in overviews are correct, etc.

[3] The time spent with the computer system

## G. Global assessment of the EMR installed in your department

| | | Strongly disagree | Disagree | Slightly disagree | Neutral | Slightly agree | Agree | Strongly disagree |
|---|---|---|---|---|---|---|---|---|
| 1 | How much do you agree with the following statement about the system: | | | | | | | |
| | The EMR system is worth the time and effort required to use it | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | non-existent | poor | fair | good | excellent |
|---|---|---|---|---|---|---|
| 2 | All considered, how would you rate your satisfaction with the EMR installed in your department? | ☐ | ☐ | ☐ | ☐ | ☐ |

3 All considered, to what extent has the system changed these two aspects of <u>your own</u> department?

| | | Signifi-cantly decreased | Decreased | Slightly decreased | No change | Slightly increased | Increased | Signifi-cantly increased |
|---|---|---|---|---|---|---|---|---|
| a | Ease of performing our department□s work | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b | Quality of our department□s work | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | non-existent | poor | fair | good | excellent |
|---|---|---|---|---|---|---|
| 4 | All considered, how would you rate the success of the EMR system installed in your department? | ☐ | ☐ | ☐ | ☐ | ☐ |

## H. Comments

E.g. Where parts of the questionnaire unclear or ambiguous? Do you have any suggestions to improvements of the current EMR system? Other comments?

## Revision 2, Norwegian (Local study 2002)

This revision was used in Aust-Agder Hospital, in the local study performed in 2002. The questionnaire shown here applies to the physicians.

2357434042 EPJ Evalueringsskjema ASA Leger
Hallvard L□rum (tlf. 73869748) og Tom H.Karlsen (tlf.37014195) IDnr 1 11a

# Leger

*Kryss av slik:* ☒
*Ikke slik:* ☒

**A. Om din stilling**

Klinisk stilling: ☐ Turnuslege ☐ Assistentlege ☐ Overlege

**B. Om din erfaring med bruk av datamaskin**

| | | Ja | Nei |
|---|---|---|---|
| 1 | Eier du en datamaskin? | ☐ | ☐ |

2 Hvor mange fingre bruker du n□r du skriver p□ maskin? ☐ To ☐ Tre eller flere ☐ Alle (evt. touch)

| 3 | Har du tidligere* brukt en datamaskin til... | Ja | Nei |
|---|---|---|---|
| a) | □ lete etter et labresultat eller svar p□ andre supplerende undersłkelser | ☐ | ☐ |
| b) | □ słke i medisinsk litteratur eller medisinske oppslagsverk | ☐ | ☐ |
| c) | tekstbehandling | ☐ | ☐ |
| d) | □ skrive inn kliniske pasientopplysninger (eks. et poliklinisk notat) | ☐ | ☐ |
| e) | □ innhente kliniske pasientopplysninger (eks. en tidligere epikrise) | ☐ | ☐ |

| | | Aldri | Sjeldnere enn m□nedlig | M□nedlig | Ukentlig | Daglig |
|---|---|---|---|---|---|---|
| 4 | Hva er den hłyeste hyppigheten du har brukt datamaskin tidligere* ? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Lavest | | Middels | | Hłyest |
|---|---|---|---|---|---|---|
| 5a | Hvordan vil du rangere dine generelle dataferdigheter? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5b | Hvordan vil du rangere dine dataferdigheter i DIPS? | ☐ | ☐ | ☐ | ☐ | ☐ |

** Fłr DIPS ble innfłrt, evt. fłr du begynte ved sykehuset*

**C. Om tilgjengelighet av datamaskiner p□ din arbeidsplass p□ sykehuse**

| | | Ja | Nei |
|---|---|---|---|
| 1 | Har du en datamaskin p□ arbeidsplassen din/kontoret ditt? | ☐ | ☐ |

| | | Aldri | Sjeldnere enn m□nedlig | M□nedlig | Ukentlig | Daglig |
|---|---|---|---|---|---|---|
| 2 | Ang□ende datamaskinen(e) som er installert p□sengepost, poliklinikk, undersłkelsesrom, o.l.: Hvor ofte hindres eller forsinkes du i □ bruke datamaskin fordi den er i bruk av andre? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Hvor ofte savner du □ ha en datamaskin der du utfłrer pasientrettet arbeid? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Hvor ofte hindres eller forsinkes du i □ bruke data-maskin pga. datafeil, systemhavari eller andre maskin-avhengige problemer? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | Hvor ofte hindres eller forsinkes du i □ bruke datamaskin pga. problemer med passord? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | Hvor ofte hindres eller forsinkes du i □ bruke datamaskin fordi datasystemet arbeider for langsomt? | ☐ | ☐ | ☐ | ☐ | ☐ |

1

**D. Om ditt bruk av DIPS til arbeidsoppgaver relatert til klinisk arbeid p□ sykehuset**

*Ved Aust-Agder Sykehus er det installert en elektronisk pasientjournal (DIPS 2000) som best□r av en "ren' elektronisk del og en del best□ende av skannet papirjournal. Sistnevnte best□r hovedsaklig av eldre dokumenter fra pasientjournalen, men ogs□ noe informasjon av nyere dato (svar p□ eksterne undersłkelser, henvisninger, etc.) Siden delen av DIPS som h□ndterer den skannede informasjonen er s□ ulik fra łvrige deler av programmet, spłr vi om den skannede delen separat.*

**D1. N□r du forventer □ kunne finne informasjonen i den<u>skannede delen av DIPS</u>, hvor ofte bruker du denne til □:**

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tilfellene | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 F□ oversikt over pasientens problemstilling | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Lete frem enkeltopplysninger fra pasientjournalen | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Fłlge resultatene av en bestemt prłve eller undersłkelse over tid | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Sl□ opp svar p□ klinisk-kjemiske laboratorieanalyser | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Sl□ opp svar p□ rłntgen, UL eller CT | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 Sl□ opp svar p□ andre supplerende undersłkelser | | | | | |
| a. Fra dokumenter som er skannet samlet ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Fra dokumenter som er skannet enkeltvis | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 Sl□ opp svar p□ nye prłver eller undersłkelser *(skannes alltid enkeltvis)* | ☐ | ☐ | ☐ | ☐ | ☐ |

**D2. N□r du ser bort fra den skannede delen av DIPS, hvor ofte bruker du DIPS til □ hjelpe deg med fłlgende arbeidsoppgaver:**

| | | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tilfellene | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|---|
| 1 | F□ oversikt over pasientens problemstilling | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Lete frem enkeltopplysninger fra pasientjournalen | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Fłlge resultatene av en bestemt prłve eller undersłkelse over tid | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Sl□ opp svar p□ nye prłver eller undersłkelser | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | Fłre daglige og/eller forefallende journalnotater | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | F□ ut samledata for en gruppe pasienter, eks. komplikasjonsrate, diagnosefordeling. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | Rekvirere klinisk-kjemiske laboratorieanalyser | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 | Sl□ opp svar p□ klinisk-kjemiske lab.-analyser | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | Sl□ opp svar p□ rłntgen, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | Sl□ opp svar p□ andre supplerende undersłkelser | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | Henvise pasienten til annen avdeling eller spesialist | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | Skrive resept | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | Skrive sykmelding | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | Samle inn pasientopplysninger til ulike lege-erkl□ringer (eks. uflrepensjon) | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | Gi skriftlig individuell informasjon til pasienten (eks. sykdommens status, medikamenter, m.m.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 | Gi skriftlig generell medisinsk-faglig informasjon til pasienten | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | Samle inn opplysninger til epikrise | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | Kontrollere og signere/godkjenne ferdig skrevne diktater | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | Utflre prosedyre- eller diagnosekoding | ☐ | ☐ | ☐ | ☐ | ☐ |

20 Annet (spesifiser)

**E1. Om din oppfatning av DIPS, <u>del for skannet papirjournal</u>**

*Her ł□nsker vi □ f□ din oppfatning av den delen av DIPS som h□ndterer**skannet** papirjournal*

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Innhold | | | | | |
| a Hvor ofte gir systemet deg akkurat den informasjonen du trenger? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonsinnholdet nok for ditt behov? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c Hvor ofte klarer systemet □ lage rapporter[1] som ser ut til □ passe akkurat for deg? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d Hvor ofte gir systemet tilstrekkelig informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Nłyaktighet [2] | | | | | |
| a Hvor ofte er systemet nłyaktig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er du fornłyd med nłyaktigheten i systemet? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Format | | | | | |
| a Hvor ofte synes du svarene fra systemet presenteres p□ en nyttig m□te? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonen klar og tydelig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Brukervennlighet | | | | | |
| a Hvor ofte er systemet brukervennlig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er systemet enkelt □ bruke? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Betimelighet | | | | | |
| a Hvor ofte f□r du den informasjonen du trenger i tide? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte gir systemet deg oppdatert informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

*[1] "Rapport" kan tolkes som utvalg eller sammendrag av opplysninger som vises p□ skjerm eller skrives ut*
*[2] F.eks. At rett journal, rett pasient og rett dokumenttype finnes frem; at informasjonen (eks. blodtrykk) presenteres med rett navn; at tallverdiene er korrekte, m.m.*

**E2. Om din oppfatning av DIPS, ren elektronisk del**

*Her ønsker vi □ få din oppfatning av DIPS **utenom** den delen som h□ndterer skannet papirjournal*

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Innhold | | | | | |
| a Hvor ofte gir systemet deg akkurat den informasjonen du trenger? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonsinnholdet nok for ditt behov? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c Hvor ofte klarer systemet □ lage rapporter som ser ut til □ passe akkurat for deg? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d Hvor ofte gir systemet tilstrekkelig informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 2 Nøyaktighet [1] | | | | | |
| a Hvor ofte er systemet nøyaktig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er du fornøyd med nøyaktigheten i systemet? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 3 Format | | | | | |
| a Hvor ofte synes du svarene fra systemet presenteres p□ en nyttig m□te? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonen klar og tydelig? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 4 Brukervennlighet | | | | | |
| a Hvor ofte er systemet brukervennlig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er systemet enkelt □ bruke? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 5 Betimelighet | | | | | |
| a Hvor ofte f□r du den informasjonen du trenger i tide? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte gir systemet deg oppdatert informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

*[1] Eks. At rett journal, rett pasient og rett dokumenttype finnes frem; at informasjonen (eks. blodtrykk) presenteres med rett navn; at tallverdiene er korrekte, m.m.*

**F. Hvordan synes du DIPS har endret gjennomfłringen av fłlgende arbeidsoppgaver ved din egen avdeling eller seksjon:**

| | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen endring | Litt lettere | Lettere | Betydelig lettere |
|---|---|---|---|---|---|---|---|
| 1 ¯ f□ oversikt over pasientens problemstilling er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 ¯ lete frem enkeltopplysninger fra pasient-journalen er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 ¯ fłlge resultatene av en bestemt prłve eller undersłkelse over tid er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 ¯ sl□ opp svar p□ nye prłver eller under-słkelser er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 ¯ fłre daglige og/eller forefallende journalnotater er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 ¯ f□ ut samledata for en gruppe pasienter, eks. komplikasjonsrate, diagnosefordeling, er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 ¯ rekvirere klinisk-kjemiske laboratorie-analyser er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 ¯ sl□ opp svar p□ klinisk-kjemiske lab.-analyser er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 ¯ sl□ opp svar p□ rłntgen, UL eller CT er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 ¯ sl□ opp svar p□ andre supplerende undersłkelser er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 ¯ henvise pasienten til annen avdeling eller spesialist er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 ¯ skrive resept er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 ¯ skrive sykmelding er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 ¯ samle inn pasientopplysninger til ulike lege-erkl□ringer (eks. uflrepensjon) er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 ¯ gi skriftlig individuell informasjon til pasienten (eks. sykdommens status, medikamenter, m.m.) er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 ¯ gi skriftlig generell medisinsk-faglig informasjon til pasienten er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 ¯ samle inn opplysninger til epikrise er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 ¯ kontrollere og signere/godkjenne ferdig skrevne diktater er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 ¯ utfłre prosedyre- eller diagnosekoding er blitt | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**G. Samlet vurdering av DIPS**

1 Alt i alt, hvordan synes du DIPS har endret fllgende to aspekter ved din egen avdeling eller seksjon:

| | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen endring | Litt lettere | Lettere | Betydelig lettere |
|---|---|---|---|---|---|---|---|
| a Gjennomflringen av arbeidet ved v□r avdeling/seksjon er blitt: | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Betydelig d□rligere | D□rligere | Litt d□rligere | Ingen endring | Litt bedre | Bedre | Betydelig bedre |
|---|---|---|---|---|---|---|---|
| b Kvaliteten p□ arbeidet ved v□r avdelingen/seksjon er blitt: | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| 2 Hvor enig eller uenig er du i fllgende utsagn: | Sv□rt uenig | Uenig | Litt uenig | B□de og | Litt enig | Enig | Sv□rt enig |
|---|---|---|---|---|---|---|---|
| DIPS er verdt den tid og de krefter det tar □ bruke det | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| 3 Alt i alt, hvor fornłyd er du med DIPS p□ din avdeling/seksjon? | Ikke i det hele tatt | Lite | Noe | Godt | Sv□rt godt |
|---|---|---|---|---|---|
| | ☐ | ☐ | ☐ | ☐ | ☐ |

| 4 Hvor vellykket er DIPS ved din avdeling/ seksjon? | Ikke vel-lykket i det hele tatt | Lite vellykket | Noe vellykket | Vellykket | Sv□rt Vellykket |
|---|---|---|---|---|---|
| | ☐ | ☐ | ☐ | ☐ | ☐ |

**H. Kommentarer**

Er det noen funksjoner i DIPS du synes fungerer spesielt godt? I s□ fall, forklar:

Er det noen funksjoner i DIPS du synes fungerer mindre godt? I s□ fall forklar:

Er det noen funksjoner i DIPS du savner spesielt? I s□ fall, forklar:

Var deler av spłrreskjemaet uklart eller tvetydig? Andre kommentarer?

## Revision 2, English translated version

2357434042 EPJ Evalueringsskjema ASA Leger
Hallvard Laerum (tlf. 73869748) og Tom H.Karlsen (tlf.37014195)
IDnr 1 11a

# Doctors

*Check like this:* ☒
*not like this:* ☒

**A. About your work position**

Clinical position: ☐ Intern ☐ Resident ☐ Consulting physician

**B. About your experience with computers**

| | | Yes | No |
|---|---|---|---|
| 1 | Do you own a computer? | ☐ | ☐ |
| 2 | How many fingers do you use when typing? | ☐ Two | ☐ Three or more ☐ All (or touch) |
| 3 | Have you earlier* used a computer for | Yes | No |
| | a) Test result retrieval | ☐ | ☐ |
| | b) Literature search | ☐ | ☐ |
| | c) Word processing | ☐ | ☐ |
| | d) Entering patient info (e.g. an outpatient note) | ☐ | ☐ |
| | e) Retrieving patient info (e.g. a previous discharge report) | ☐ | ☐ |

| | | Never | Less frequently than monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|---|
| 4 | In the past*, what is the most frequent you used a computer? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Lowest | | Average | | Highest |
|---|---|---|---|---|---|---|
| 5a | How would you rate your computer skills in general? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5b | How would you rate your computer skills concerning DIPS? | ☐ | ☐ | ☐ | ☐ | ☐ |

** Before DIPS was installed, or before you started working in the hospital*

**C. About the availability of computers at your working place at the hospital**

| | | Yes | No |
|---|---|---|---|
| 1 | Do you have a computer in your office? | ☐ | ☐ |

| | | Never | Less frequently than monthly | Monthly | Weekly | Daily |
|---|---|---|---|---|---|---|
| 2 | About the computers installed in the ward, at the outpatient clinic offices, investigation rooms, etc: How often are you prevented from or delayed in using them because others are using them? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | How often do you miss having a computer available where you do patient-related work? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | How often are you prevented from or delayed in using a computer due to computer errors, system crashes or other machine-related problems? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | How often are you prevented from or delayed in using a computer due to password problems? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | How often are you prevented from or delayed in using a computer because the system is working too slowly? | ☐ | ☐ | ☐ | ☐ | ☐ |

**D. About your use of DIPS for clinical tasks in the hospital**

*At Aust-Agder Hospital an electronic medical record (DIPS 2000) is installed, consisting of "purely" electronic data and scanned paper records. The latter contains mainly older documents from the patient record, but also some newer information (external lab tests, referrals, etc.) Since the part of DIPS handling the scanned information differs so much from the rest of the system, we are keeping it separate in this questionnaire.*

**D1. When you expect to find the information in the scanned part of DIPS, how often do you use it for the following tasks:**

| | Never/ almost never | Seldom | About half of the occasions | Most of the occasions | Always/ almost always |
|---|---|---|---|---|---|
| 1 Review the patient□s problems | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Seek out specific information from patient records | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Follow the results of a particular test or investigation over time | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Obtain the results from clinical biochemical laboratory analyses | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Obtain the results from X-ray, ultrasound or CT investigations | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 Obtain the results from other supplementary investigations | | | | | |
| a. from documents scanned in sections ("bulk") | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. from documents scanned one sheet at a time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 Obtain the results from new tests or investigations *(always scanned on sheet at time)* | ☐ | ☐ | ☐ | ☐ | ☐ |

**D2. The scanned document images notwithstanding, how often do you use DIPS to assist you with the following tasks:**

| | | Never/ almost never | Seldom | About half of the occasions | Most of the occasions | Always/ almost always |
|---|---|---|---|---|---|---|
| 1 | Review the patient□s problems | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | Seek out specific information from patient records | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | Follow the results of a particular test or investigation over time | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | Obtain the results from new tests or investigations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | Enter daily notes | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | Produce data reviews for specific patient groups, e.g. complication rate, distribution of diagnoses. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | Order clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 | Obtain the results from clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | Obtain the results from X-ray, ultrasound or CT investigations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | Obtain the results from other supplementary investigations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | Refer the patient to other departments or specialists | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | Write prescriptions | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | Complete sick-leave forms | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | Collect patient information for various medical declarations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | Give written individual information to patients, e.g. about medications, disease status | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 | Give written general medical information to patients | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | Collect patient info for discharge reports | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | Check and sign typed dictations | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | Register codes for diagnosis or performed procedures | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 | Other (please specify) | | | | | |

**E1. About your satisfaction with DIPS, the part handling the scanned paper records**

*Here we would like to learn your opinion of the part of DIPS handling the **scanned** paper records*

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 1 Content | | | | | |
| a How often does the system provide the precise information you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the information content meet your needs? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c How often does the system provide reports[1] that seem to be just about exactly what you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d How often does the system provide sufficient information? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 2 Accuracy [2] | | | | | |
| a How often is the system accurate? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often are you satisfied with the accuracy of the system? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 3 Format | | | | | |
| a How often do you think the output is presented in a useful format? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the information clear? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 4 Ease of use | | | | | |
| a How often is the system user-friendly? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the system easy to use? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 5 Timeliness | | | | | |
| a How often do you get the information you need in time? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the system provide up-to-date information? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *"Report" may be interpreted as a selection or resume of information shown on the screen or printed*
[2] *E.g. that correct journal, patient and document type is displayed; that the information (e.g. blood pressure) is presented having the right name; that the values are correct, etc.*

**E2. About your satisfaction with DIPS, the part handling the regular electronic data**

*Here we would like to learn your opinion of DIPS, **regardless of** the part handling the scanned paper records*

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 1 Content | | | | | |
| a How often does the system provide the precise information you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the information content meet your needs? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c How often does the system provide reports that seem to be just about exactly what you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d How often does the system provide sufficient information? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 2 Accuracy [1] | | | | | |
| a How often is the system accurate? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often are you satisfied with the accuracy of the system? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 3 Format | | | | | |
| a How often do you think the output is presented in a useful format? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the information clear? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 4 Ease of use | | | | | |
| a How often is the system user-friendly? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the system easy to use? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 5 Timeliness | | | | | |
| a How often do you get the information you need in time? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the system provide up-to-date information? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *E.g. that correct journal, patient and document type is displayed; that the information (e.g. blood pressure) is presented having the right name; that the values are correct, etc.*

**F. In your opinion, how has DIPS changed the performance of the following tasks in your department:**

| | | Significantly more difficult | More difficult | Slightly more difficult | No change | Slightly easier | Easier | Signifi-cantly easier |
|---|---|---|---|---|---|---|---|---|
| 1 | To review the patient□s problems has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 | To seek out specific information from patient records has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 | To follow the results of a particular test or investigation over time has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 | To obtain the results from new tests or investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 | To enter daily notes has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 | To produce data reviews for specific patient groups (eg. complication rate) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 | To order clinical biochemical laboratory analyses has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 | To obtain the results from clinical biochemical laboratory analyses has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9 | To obtain the results from X-ray, ultrasound or CT investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | To obtain the results from other supplementary investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | To refer the patient to other departments or specialists has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | To write prescriptions has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | To complete sick-leave forms has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | To collect patient information for various medical declarations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | To give written individual information to patients, (e.g. about medications, disease status) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 | To give written general medical information to patients has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | To collect patient info for discharge reports has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | To check and sign typed dictations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | The register codes for diagnosis or performed procedures has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**G. Global assessment of DIPS**

1 All considered, to what extent has DIPS changed these two aspects of your own department?

| | Significantly more difficult | More difficult | Slightly more difficult | No change | Slightly easier | Easier | Signifi-cantly easier |
|---|---|---|---|---|---|---|---|
| a The performance of our department's work has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Significantly decreased | Decreased | Slightly decreased | No change | Slightly increased | Increased | Signifi-cantly increased |
|---|---|---|---|---|---|---|---|
| b The quality of our department's work has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

2 How much do you agree with the following statement:

| | Strongly disagree | Disagree | Slightly disagree | Neutral | Slightly agree | Agree | Strongly disagree |
|---|---|---|---|---|---|---|---|
| DIPS is worth the time and effort required to use it | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

3 All considered, how would you rate your satisfaction with DIPS in your department?

| non-existent | poor | fair | good | excellent |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

4 All considered, how would you rate the success of DIPS in your department?

| non-existent | poor | fair | good | excellent |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

**H. Comments**

In your opinion, are any of the functions in DIPS particularly useful? If so, please explain

In your opinion, are any of the functions in DIPS not very useful? If so, please explain

Do you miss any functionality in DIPS? If so, please explain

Were parts of the questionnaire unclear or ambiguous? Other comments?

## Revision 3, Norwegian (Validation studies 2003)

In the validation studies, two questionnaires appeared in the test-retest study, named form 1 and 2. The latter is identical to the former, except from omission of the first two questions, which were superfluous in the second leg of the test-retest study. Only form 1 is shown here.

**7052571782** EPJ Kvalitetssikring Skjema 1 v2.1
Hallvard L□rum (tlf. 73598826) IDnr ☐☐☐☐

### Kvalitetssikring av elektronisk pasientjournal - Skjema 1

*I dette spłrreskjemaet łnsker vi □ f□ vite noe om din praktiske bruk av og ditt syn p□ elektronisk pasientjournal ved ditt sykehus. Med elektronisk pasientjournal mener vi i denne sammenheng et av fllgende datasystemer: DocuLive, DIPS eller In fomedix (IMx)*

*Kryss av slik:* ☒
*Ikke slik:* ☒

**A. Om din stilling**

1 Har du jevnlig kontakt med pasienter i din stilling ved sykehuset ? ☐ Nei ☐ Ja

2 Har du arbeidet i mer enn tre m□neder ved sykehuset? ☐ Nei ☐ Ja

*Hvis du svarte "nei" p□ en av disse spłrsm□lene, trenger du ikke fylle ut resten av spłrreskjemaet. Vi ser likevel helst at du returnerer spłrreskjemaet i vedlagte svarkonvolutt.*

**B1. Om ditt bruk av elektronisk pasientjournal til arbeidsoppgaver innen klinisk arbeid p□ sykehuset**
*Fłrst łnsker vi □ vite noe om ditt bruk av elektronisk pasientjournal til bestemte arbeidsoppgaver i din kliniske hverdag.*

Hvor ofte bruker du elektronisk pasientjournal (EPJ[1]) til □ hjelpe deg med fllgende arbeidsoppgaver?
Svar ved □ krysse av for et av alternativene i kolonne 1-5. Hvis EPJ ved din avdeling ikke stłtter denne arbeidsoppgaven (dvs. data-programmet kan ikke brukes til denne arbeidsoppgaven) krysser du i stedet av i kolonne A. Hvis arbeidsoppgaven ikke er aktuell for deg, krysser du av i kolonne B.

| | 1 Aldri/ nesten aldri | 2 Sjelden | 3 Omtrent halvparten av tilfellene | 4 Som regel | 5 Alltid/ nesten alltid | A V□r EPJ[1] stłtter ikke dette | B Denne arbeids-oppgaven er ikke aktuell for meg |
|---|---|---|---|---|---|---|---|
| 1 F□ oversikt over pasientens problemstilling | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Lete frem enkeltopplysninger fra pasientjournalen | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Fłlge resultatene av en bestemt prłve eller undersłkelse over tid | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Sl□ opp svar p□ nye prłver eller undersłkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Fłre daglige og/eller forefallende journalnotater | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 F□ tak i opplysninger om prosedyre for utredning eller behandling | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 F□ svar p□ spłrsm□l om generell med.-faglig kunnskap, eks. vedr. behandling, symptomer, komplikasjoner, o.l. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 F□ ut samledata for en gruppe pasienter, eks. diagnosefordeling, komplikasjonsrate | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *DocuLive, DIPS eller Infomedix*

| (B1, forts.) | 1 Aldri/ nesten aldri | 2 Sjelden | 3 Omtrent halvparten av tilfellene | 4 Som regel | 5 Alltid/ nesten alltid | A V□r EPJ stłtter ikke dette | B Denne arbeids-oppgaven er ikke aktuell for meg |
|---|---|---|---|---|---|---|---|
| 9 Rekvirere klinisk-kjemiske laboratorieanalyser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 Sl□ opp svar p□ klinisk-kjemiske laboratorieanalyser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 Rekvirere rłntgenundersłkelser, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 Sl□ opp svar p□ rłntgenundersłkelser, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 Rekvirere andre supplerende undersłkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 Sl□ opp svar p□ andre supplerende undersłkelser | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 Henvise pasienten til annen avdeling eller spesialist | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 Ordinere behandling direkte (medikamentell, operativ eller annen) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 Skrive resept | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 Skrive sykmelding | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 Samle inn pasientopplysninger til ulike legeerkl□ringer (eks. uflrepensjon) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 Gi skriftlig individuell informasjon til pasienten (eks. sykdommens status, medikamenter, m.m.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 Gi skriftlig generell medisinsk-faglig informasjon til pasienten | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 Samle inn opplysninger til epikrise | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 Kontrollere og signere ferdig skrevne diktater | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24 Utflre prosedyre- eller diagnosekoding | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**B2. Generell bruk av EPJ og papirbasert pasientjournal**

*N□ ønsker vi □ vite noe om den generelle bruken av papirbasert pasientjournal og EPJ i ditt arbeid med pasienter.*

| | 1 Aldri/ nesten aldri | 2 Sjelden | 3 Omtrent halvparten av tilfellene | 4 Som regel | 5 Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Alt i alt, hvor ofte bruker du den papirbaserte pasient-journalen eller kurven som informasjonskilde i det daglige pasientarbeidet? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Alt i alt, hvor ofte bruker du EPJ som informasjonskilde i det daglige pasientarbeidet? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Alt i alt, hvor ofte bruker du EPJ n□r du skal overf□re pasientrelatert informasjon til andre personer[1] eller instanser (ved utskrift p□ papir eller ved elektronisk overf□ring) | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *Pasient og alt relevant helsepersonell*

**C. Om gjennomf□ringen av arbeidsoppgaver innen klinisk arbeid n□r EPJ benyttes**

*Selv om sp□rsm□lene i seksjon B1 og B2 kartlegger bruken av EPJ til ulike arbeidsoppgaver, sier de lite om hvor godt EPJ st□tter dem. I denne seksjonen ønsker vi □ vite hvor lett eller vanskelig det er □ gjennomf□re hver arbeidsoppgave n□r du bruker EPJ.*

Hvordan synes du EPJ har endret gjennomf□ringen av f□lgende arbeidsoppgaver i forhold til tidligere rutiner?
Kryss av "Vet ikke/Ikke aktuelt" hvis du aldri har brukt annet enn EPJ til denne arbeidsoppgaven, eller hvis EPJ ved din avdeling ikke st□tter denne oppgaven.

| | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen forskjell | Litt lettere | Lettere | Betydelig lettere | Vet ikke/ Ikke ak-tuelt |
|---|---|---|---|---|---|---|---|---|
| 1 ¯ f□ oversikt over pasientens problemstilling er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 ¯ lete frem enkeltopplysninger fra pasientjournalen er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 ¯ f□lge resultatene av en bestemt pr□ve eller unders□kelse over tid er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 ¯ sl□ opp svar p□ nye pr□ver eller unders□kelser er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 ¯ f□re daglige og/eller forefallende journalnotater er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 ¯ f□ tak i opplysninger om prosedyre for utredning eller behandling er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 ¯ f□ svar p□ sp□rsm□l om generell med.-faglig kunnskap, eks. vedr. behandling, symptomer, o.l. er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 ¯ f□ f□ ut samledata for en gruppe pasienter, er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| (C. forts.) | | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen forskjell | Litt lettere | Lettere | Betydelig lettere | Vet ikke/ Ikke ak-tuelt |
|---|---|---|---|---|---|---|---|---|---|
| 9 | ¯ rekvirere klinisk-kjemiske laboratorieanalyser er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | ¯ sl□ opp svar p□ klinisk-kjemiske laboratorieanalyser er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | Rekvirere rłntgenundersłkelser, UL eller CT | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | ¯ sl□ opp svar p□ rłntgenundersłkelser, UL eller CT er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | ¯ rekvirere andre supplerende undersłkelser er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | ¯ sl□ opp svar p□ andre supplerende undersłkelser er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | ¯ henvise pasienten til annen avdeling eller spesialist er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 | ¯ ordinere direkte behandling (medikamentell, operativ) er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | ¯ skrive resept er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | ¯ skrive sykmelding er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | ¯ samle inn pasientopplysninger til ulike legeerkl□ringer er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 | ¯ gi skriftlig individuell informasjon til pasienten (eks. sykdommens status, medikamenter) er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 | ¯ gi skriftlig generell medisinsk-faglig informasjon til pasienten er blitt.... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 | ¯ samle inn opplysninger til epikrise er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 | ¯ kontrollere og signere ferdig skrevne diktater er blitt.... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24 | ¯ utflre prosedyre- eller diagnosekoding er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**D. Om din oppfatning av den elektroniske pasientjournalen (EPJ [1] ) ved din avdeling**

*I denne seksjonen ønsker vi □ få ditt syn på den elektroniske pasientjournalen ved □ utdype sentrale aspekter ved bruk av denne type systemer.*

| | Aldri/ nesten aldri | Sjelden | Omtrent halvparten av tiden [4] | Som regel | Alltid/ nesten alltid |
|---|---|---|---|---|---|
| 1 Innhold | | | | | |
| a Hvor ofte gir systemet deg akkurat den informasjonen du trenger? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonsinnholdet nok for ditt behov? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c Hvor ofte klarer systemet □ lage rapporter[2] som ser ut til □ passe akkurat for deg? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d Hvor ofte gir systemet tilstrekkelig informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Nøyaktighet [3] | | | | | |
| a Hvor ofte er systemet nøyaktig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er du fornøyd med nøyaktigheten i systemet? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Format | | | | | |
| a Hvor ofte synes du svarene fra systemet presenteres på en nyttig måte? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er informasjonen klar og tydelig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Brukervennlighet | | | | | |
| a Hvor ofte er systemet brukervennlig? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte er systemet enkelt □ bruke? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Betimelighet | | | | | |
| a Hvor ofte får du den informasjonen du trenger i tide? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Hvor ofte gir systemet deg oppdatert informasjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *DocuLive, DIPS eller Infomedix*

[2] *Med 'rapport' menes enhver sammenstilling eller ethvert sammendrag av informasjon som skrives ut eller vises på skjerm*

[3] *F.eks. at rett journal, rett pasient og rett dokumenttype finnes frem; at informasjonen (eks. blodtrykk) presenteres med rett navn; at informasjonen som presenteres er relevant; at samledata i rapporter er korrekte, m.m.*

[4] *Tiden du normalt bruker med datasystemet*

**E. Samlet vurdering av den elektroniske pasientjournalen (EPJ) ved din avdeling**

*Til slutt i denne undersłkelsen ønsker vi □ f□ din mening om den elektronisk pasientjournalen ved din avdeling, alt tatt i betraktning.*

| | Sv□rt uenig | Uenig | Litt uenig | B□de og | Litt enig | Enig | Sv□rt enig |
|---|---|---|---|---|---|---|---|
| 1 Hvor enig eller uenig er du i fllgende utsagn: EPJ er verdt den tid og de krefter det tar □ bruke det | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Ikke i det hele tatt | Lite | Noe | Godt | Sv□rt godt |
|---|---|---|---|---|---|
| 2 Alt i alt, hvor fornłyd er du med den EPJ du bruker p□ din avdeling/seksjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

3 Alt i alt, hvordan synes du EPJ har endret fllgende tre aspekter ved din avdeling eller seksjon:

| | Betydelig vanske-ligere | Vanske-ligere | Litt vanske-ligere | Ingen endring | Litt lettere | Lettere | Betydelig lettere |
|---|---|---|---|---|---|---|---|
| a Gjennomfłringen av arbeidet ved v□r avdeling/seksjon er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b Gjennomfłringen av *mine egne* arbeidsoppgaver er blitt... | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Betydelig d□rligere | D□rligere | Litt d□rligere | Ingen endring | Litt bedre | Bedre | Betydelig bedre |
|---|---|---|---|---|---|---|---|
| c Kvaliteten p□ arbeidet ved v□r avdelingen/seksjon er blitt: | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Ikke vel-lykket i det hele tatt | Lite vellykket | Noe vellykket | Vellykket | Sv□rt Vellykket |
|---|---|---|---|---|---|
| 4 Hvor vellykket er den EPJ du bruker ved din avdeling/seksjon? | ☐ | ☐ | ☐ | ☐ | ☐ |

**E. Kommentarer**

## Revision 3, English translated version

In the validation studies, two questionnaires appeared in the test-retest study, named form 1 and 2. The latter is identical to the former, except from omission of the first two questions, which were superfluous in the second leg of the test-retest study. Only form 1 is shown here.

7052571782 EPJ Kvalitetssikring Skjema 1 v2.1
Hallvard Lrum (tlf. 73598826) IDnr ☐☐☐☐

### Evaluation of electronic medical records - Questionnaire 1

*In this questionnaire, we would like to know about your use of and perception of the electronic medical record in your hospital. By electronic medical record, we mean one of the following computer software systems: DocuLive, DIPS or Infomedix (IMx).*

*Check like this* ☒
*INot like this* ☒

**A. About your position**

1 Do you regularly work with patients in this hospital? ☐ Yes ☐ No

2 Have you been working for more than three months in this hospital? ☐ Yes ☐ No

*If your answer was "no" to any of these questions, you don't have to complete the rest of this questionnaire. Still, we would very much like you to return the questionnaire in the enclosed envelope.*

**B1. About your use of electronic medical records for clinical tasks in the hospital**

*First, we would like to know how often you use the electronic medical record for certain tasks in your everyday clinical work.*

How often do you use the electronic medical record (EMR[1]) to assist you with the following tasks?
Please answer by check one of the alternatives in column 1-5. If the EMR in your department doesn't support this task (i.e. the software can't be used for this task), please check column A. If this task does not apply to you, please check column B.

| | 1 Never/ almost never | 2 Seldom | 3 About half of the occasions | 4 Most of the occasions | 5 Always/ almost always | A Our EMR [1] doesn't support this task | B This task doesn't apply to me |
|---|---|---|---|---|---|---|---|
| 1 Review the patients problems | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 Seek out specific information from patient records | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 Follow the results of a particular test or investigation over time | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 Obtain the results from new test or investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 Enter daily notes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 Obtain information on investigation or treatment procedures | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 Answer questions concerning general medical knowledge (e.g. concerning treatment, symptoms, complications etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 Produce data reviews for specific patient groups, e.g. complication rate, diagnoses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *DocuLive, DIPS or Infomedix*

| (B1, cont.) | 1 Never/ almost never | 2 Seldom | 3 About half of the occa-sions | 4 Most of the occa-sions | 5 Always/ almost always | A Our EMR doesn't support this task | B This task doesn't apply to me |
|---|---|---|---|---|---|---|---|
| 9 Order clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 Obtain the results from clinical biochemical laboratory analyses | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 Order X-ray, ultrasound or CT investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 Obtain the results from X-ray, ultrasound or CT investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 Order other supplementary investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 Obtain the results from other supplementary investigations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 Refer the patient to other departments or specialists | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 Order treatment directly (e.g. medicines, operations etc.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 Write prescriptions | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 Write sick-leave notes | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 Collect patient information for various medical declarations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 Give written individual information to patients, e.g. about medications, disesase status | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 Give written general medical information to patients | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 Collect patient info for discharge reports | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 Check and sign typed dictations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24 Register codes for diagnosis or performed procedures | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**B2. General use of EMR and paper-based medical record**

*Now, we'd like to know about your general use of paper-based medical records and EMR in your patient-related work*

| | 1 Never/ almost never | 2 Seldom | 3 About half of the occa-sions | 4 Most of the occa-sions | 5 Always/ almost always |
|---|---|---|---|---|---|
| 1 All considered, how often do you use the paper-based medical record or the chart summary as an information source in your daily clinical work? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 All considered, how often do you use the EMR as an information source in your daily clinical work? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 All considered, how often do you use the EMR when transferring patient-related information to other persons [1] or instances (by printouts or by electronic transmission) | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *The patient and all relevant health personell*

**C. About the performance of clincial work tasks when using the EMR**

*Although the questions in section B1 and B2 survey the use of EMR for various clinical tasks, they do not describe how the the EMR supports these tasks. In this section we would like to know the ease of performing each task when using the EMR.*

Compared to previous routines, how has the EMR in your opinion changed the performance of the following tasks?
Check "Don't know/Not applicable" if you have never used anything else than the EMR for the task, or if the EMR in your department doesn't support it.

| | Signifi-cantly more difficult | More difficult | Slightly more difficult | No change | Slightly easier | Easier | Signifi-cantly easier | Don't know/ Not applic-able |
|---|---|---|---|---|---|---|---|---|
| 1 To review the patients problems has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2 To seek out specific information from patient records has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3 To follow the results of a particular test or investigation over time has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4 To obtain the results from new tests or investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5 To enter daily notes has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 To obtain information on investigation or treatment procedures has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7 To answer questions concerning general medical knowledge (e.g. concerning treat-ment, symptoms, complications etc.) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8 To produce data reviews for specific patient groups (eg. complication rate) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**(C. continued)**

| | | Significantly more difficult | More difficult | Slightly more difficult | No change | Slightly easier | Easier | Signifi-cantly easier | Don□t know/ Not applic-able |
|---|---|---|---|---|---|---|---|---|---|
| 9 | To order clinical biochemical laboratory analyses has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10 | To obtain the results from clinical biochemical laboratory analyses has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11 | To order X-ray, ultrasound or CT investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12 | To obtain the results from X-ray, ultrasound or CT investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 | To order other supplementary investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14 | To obtain the results from other supplementary investigations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15 | To refer the patient to other departments or specialists has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 16 | To order treatment directly (e.g. medicines, operations etc.) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17 | To write prescriptions has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18 | To complete sick-leave forms has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 | To collect patient information for various medical declarations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20 | To give written individual information to patients, (e.g. about medications, disesase status) has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21 | To give written general medical information to patients has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22 | To collect patient information for discharge reports has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23 | To check and sign typed dictations has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24 | The register codes for diagnosis or performed procedures has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**D. About your satisfaction with the electronic medical record (EMR [1] ) in your department**

*In this section we would like to know your view of the electronic medical record by asking about central aspect of using such systems*

| | Never/ almost never | Seldom | About half of the time [4] | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 1 Content | | | | | |
| a How often does the system provide the precise information you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the information content meet your needs? | ☐ | ☐ | ☐ | ☐ | ☐ |
| c How often does the system provide reports [2] that seem to be just about exactly what you need? | ☐ | ☐ | ☐ | ☐ | ☐ |
| d How often does the system provide sufficient information? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 2 Accuracy [3] | | | | | |
| a How often is the system accurate? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often are you satisfied with the accuracy of the system? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 3 Format | | | | | |
| a How often do you think the output is presented in a useful format? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the information clear? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 4 Ease of use | | | | | |
| a How often is the system user-friendly? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often is the system easy to use? | ☐ | ☐ | ☐ | ☐ | ☐ |

| | Never/ almost never | Seldom | About half of the time | Most of the time | Always/ almost always |
|---|---|---|---|---|---|
| 5 Timeliness | | | | | |
| a How often do you get the information you need in time? | ☐ | ☐ | ☐ | ☐ | ☐ |
| b How often does the system provide up-to-date information? | ☐ | ☐ | ☐ | ☐ | ☐ |

[1] *DocuLive, DIPS or Infomedix*

[2] *A □report□ in this context is any collection or summary of information printed or shown on screen*

[3] *E.g. correct record, corrent patient and correct document type is shown; that the information (e.g. blood pressure) is presented using the correct name, that the information presented is relevant; that summaries in reports are correct, etc.*

[4] *The time normally spent using the system*

**E. Global assessment of the electronic medical record (EMR) in your department**

*Finally, we would like to know your opinion about the electronic medical record in your department, all considered.*

| | | Strongly disagree | Disagree | Slightly disagree | Neutral | Slightly agree | Agree | Strongly disagree |
|---|---|---|---|---|---|---|---|---|
| 1 | How much do you agree with the following statement: EMR is worth the time and effort required to use it | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | non-existent | poor | fair | good | excellent |
|---|---|---|---|---|---|---|
| 2 | All considered, how would you rate your satisfaction with DIPS in your department? | ☐ | ☐ | ☐ | ☐ | ☐ |

3 All considered, to what extent has EMR changed these three aspects of your own department?

| | | Significantly more difficult | More difficult | Slightly more difficult | No change | Slightly easier | Easier | Significantly easier |
|---|---|---|---|---|---|---|---|---|
| a | The performance of our department□s work has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b | The performance of *my own* tasks has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Significantly decreased | Decreased | Slightly decreased | No change | Slightly increased | Increased | Significantly increased |
|---|---|---|---|---|---|---|---|---|
| c | The quality of our department□s work has become | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | non-existent | poor | fair | good | excellent |
|---|---|---|---|---|---|---|
| 4 | All considered, how would you rate the success of the EMR system installed in your department? | ☐ | ☐ | ☐ | ☐ | ☐ |

**E. Comments**

# REFERENCES


1. Hersh WR. Medical informatics: improving health care through information. *JAMA* 2002;**288**:1955-8.

2. Bemmel JH, Musen MA. What is Medical Informatics? In Musen MA, Helder JC, Helder JC, eds. *Handbook of medical informatics*, p XXXI-XXXIII. Heidelberg.: Springer., 1997.

3. Shortliffe E, Blois MS. The computer meets medicine and biology: Emergence of a discipline. In Perreault LE, Shortliffe EH, eds. *Medical informatics: computer applications in health care and biomedicine*, p 1. New York: Springer, 2000.

4. Journal of the American Medical informatics Association www.jamia.org Last updated 1-9-2003 Last accessed 1-9-2003

5. International Journal of Medical informatics www.imia.org Last updated 1-9-2003 Last accessed 1-9-2003

6. Methods of Information in Medicine http://www.schattauer.de/zs/startz.asp?load=/zs/methods/main.asp Last updated 1-9-2003 Last accessed 1-9-2003

7. BioMed Central Medical informatics and Decision Making http://www.biomedcentral.com/1472-6947/ Last updated 2003 Last accessed 2003

8. Brender J. Methodology for constructive assessment of IT-based systems in an organisational context. *Int.J.Med.Inf.* 1999;**56**:67-86.

9. Perreault LE, Shortliffe EH. Medical informatics: computer applications in health care and biomedicine. New York: Springer, 2000.

10. Unified Medical Language System (UMLS) http://www.nlm.nih.gov/research/umls/ Last updated 2003 Last accessed 2-6-0003

11. Shannon CE. A mathematical theory of communication. *Bell Syst Tech J* 1948;**27**:379-423.

12. Whiting-O'Keefe QE, Simborg DW, Epstein WV, Warger A. A computerized summary medical record system can provide more information than the standard medical record. *JAMA* 1985;**254**:1185-92.

13. Mamlin JJ,.Baker DH. Combined time-motion and work sampling study in a general medicine clinic. *Med Care* 1973;**11**:449-56.

14. Tang PC, Fafchamps D, Shortliffe EH. Traditional medical records as a source of clinical data in the outpatient setting. *Proc.Annu.Symp.Comput.Appl.Med.Care* 1994;575-9.

15. Kohn LT, Corrigan J, Donaldson MS. To err is human: building a safer health system. Washington: National Academy Press, 2000.

16. Dick RS, Steen EB. The Computer-based Patient Record - An Essential Technology for Health Care, Revised Edition. Washington D.C.: Institute of Medicine, National Academy Press, 1997.

17. Nohr C, Kristensen M, Andersen SK, Vingtoft S, Lippert S, Berstein K *et al*. Shared experience in 13 local Danish EPR projects: the Danish EPR Observatory. *Medinfo.* 2001;**10**:670-4.

18. Berg M. Implementing information systems in health care organizations: myths and challenges. *Int.J.Med.Inf.* 2001;**64**:143-56.

19. Westbrook, J. I. and Gosling, A. S. The impact of point of care clinical systems on health care: A review of the evidence and a framework for evaluation. 1-59. 2002. Kensington, Centre for Health Informatics, University of NSW. (Report)

20. Waegemann CP. The five levels of electronic health records [letter]. *MD Comput.* 1996;**13**:199-203.

21. Moehr JR. Evaluation: salvation or nemesis of medical informatics? *Comput.Biol.Med* 2002;**32**:113-25.

22. Aranow M. What works. Boston Medical Center. For implementation of a clinical information system with CPOE that has reduced the potential for medical errors and virtually eliminated the processes of verbal and handwritten orders. *Health Manag.Technol.* 2003;**24**:25.

23. Shortliffe EH. The evolution of electronic medical records. *Acad.Med.* 1999;**74**:414-9.

24. PubMed http://www.ncbi.nlm.nih.gov/entrez/ Last updated 2003 Last accessed 3-6-0003

25. KITH Elektronisk pasientjournal standard: Arkitektur, arkivering og tilgangsstyring http://www.kith.no/EPJ/rap.htm Last updated 2001 Last accessed 22-8-2002

26. Doll WJ,.Torkzadeh G. The measurement of end-user computing satisfaction - theoretical and Methodological issues. *MIS Quarterly* 1991;**15**:5-10.

27. Gorman PN. Information Needs of Physicians. *Journal of the American Society for Information Science* 1995;**46**:729-36.

28. Smith R. What clinical information do doctors need? [see comments]. *BMJ* 1996;**313**:1062-8.

29. Berg, M. Lessons from a dinosaur: mediating is research through an anlysis of the medical record. Baskerville, R., Stage, J., and DeGross, J. I. 169. 2000. Aalborg, Kluwer. IFIP Conference Proceedings, Organizational and Social Perspectives on IT 2000. (Conference Proceeding)

30. Wyatt JC. Clinical data systems, Part 1: Data and medical records [see comments]. *Lancet* 1994;**344**:1543-7.

31. Muter P,.Maurutto P. Reading and skimming from computer screens and books: the paperless office revisited? *Behaviour and Information Technology* 1991;**10**:257-66.

32. Nygren E,.Henriksson P. Reading the medical record. I. Analysis of physicians' ways of reading the medical record. *Comput.Methods Programs Biomed.* 1992;**39**:1-12.

33. Friedman CP, Wyatt JC. Evaluation methods in medical informatics. New York: Springer, 1997.

34. Grimsmo A, Grimstad SA, Lilleholt O, Snoen SE, Storset B. [Information for planning and comparison in municipalities. Use of data from the EDP medical records in general practice]. *Tidsskr.Nor Laegeforen.* 1994;**114**:1977-82.

35. Lærum H, Ellingsen G, Faxvaag A. [Electronic medical records in somatic hospitals--availability and clinical use]. *Tidsskr.Nor Laegeforen.* 2002;**122**:2540-3.

36. Ellingsen G,.Monteiro E. Big is beautiful: electronic patient records in large Norwegian hospitals 19082-2001. *The Scandinavian Journal of Information Systems* 2002.

37. Lærum H, Ellingsen G, Faxvaag A. Doctors' use of electronic medical records systems in hospitals: cross sectional survey. *BMJ* 2001;**323**:1344-8.

38. KITH Elektronisk pasientjournal standard: Arkitektur, arkivering og tilgangsstyring http://www.kith.no/EPJ/rap.htm Last accessed 22-8-0002

39. Suchman EA. Evaluative research - principles and practice in public service & social action programs. New York: Russell Sage, 1967.

40. Jayasuriya R. Evaluating health information systems: an assessment of frameworks. *Aust.Health Rev.* 1997;**20**:68-85.

41. Avgerou C. Evaluating information systems by consultation and negotiation. *International Journal of Information Management* 1995;**15**:427-36.

42. Friedman CP, Wyatt JC. Evaluation as a field. *Evaluation methods in medical informatics*, pp 17-39. New York: Springer, 1997.

43. Symons V,.Walsham G. The evaluation of information systems: A critique. *Journal of Applied Systems Analysis* 1988;**15**:119-32.

44. Brender, J. Methodological and methodical perils and pitfalls within assessment studies performed on IT-based solutions in healthcare. 2002. Virtual Centre for Health Informatics, Aalborg University. Technical Report of the MUP-IT Project. (Report)

45. Friedman CP, Wyatt JC. Challenges of evaluation in medical informatics. *Evaluation methods in medical informatics*, pp 1-12. New York: Springer, 1997.

46. Heathfield HA, Pitty D, Hanka R. Evaluating information technology in health care: barriers and challenges. *BMJ* 1998;**316**:1959-61.

47. Doolan DF, Bates DW, James BC. The use of computers for clinical care: a case series of advanced U.S. sites. *J Am Med Inform.Assoc.* 2003;**10**:94-107.

48. Rogers JL, Haring OM. The impact of a computerized medical record summary system on incidence and length of hospitalization. *Med.Care* 1979;**17**:618-30.

49. Tierney WM, Miller ME, Overhage JM, McDonald CJ. Physician inpatient order writing on microcomputer workstations. Effects on resource utilization. *JAMA* 1993;**269**:379-83.

50. Bates DW, Teich JM, Lee J, Seger D, Kuperman GJ, Ma'luf N *et al*. The impact of computerized physician order entry on medication error prevention. *J.Am.Med.Inform.Assoc.* 1999;**6**:313-21.

51. Loo ROvd. Overview of Published Assessment and Evaluation Studies. In Gennip EMSJv, Talmon JL, eds. *Assessment and evaluation of information technologies in medicine*, pp 261-81. Amsterdam.: IOS Press., 1995.

52. Massaro TA. Introducing physician order entry at a major academic medical center: I. Impact on organizational culture and behavior. *Acad.Med.* 1993;**68**:20-5.

53. Heeks, R., Mundy, D., and Salazar, A. Why Health Care Information Systems Succeed or Fail. 9. 1999. Institute for Development Policy and Management, University of Manchester. Information Systems for Public Sector Management: Working Papers. 1999. (Report)

54. Brender, J. Methodology for Assessment of Medical IT-based Systems - in an organisational context. 1-289. 1997. Department of Medical Informatics and Image Analysis, Aalborg University, Denmark. (Thesis/Dissertation)

55. Southon G, Sauer C, Dampney K. Lessons from a failed information systems initiative: issues for complex organisations. *Int.J Med Inf.* 1999;**55**:33-46.

56. Heathfield, H. A., Felton, D., and Clamp, S. Evaluation of Electronic Patient and Health Record Projects. Heathfield, H. A. 2001-IA-533, 1-80. 2002. England, ERDIP Programme, NHS Information Authority. (Report)

57. Gennip EMSJv, Talmon JL. Assessment and evaluation of information technologies in medicine / edited by E. M. S. J. van Gennip and J. L. Talmon. Amsterdam.: IOS Press., 1995.

58. Berwick, D., Godfrey, A., and Roessner, J. Curing Health Care: New Strategies for Quality Improvement—a Report on the National Demonstration Project on Quality in Health Care. 43-44. 1991. San Fransisco, Jossey-Bass Publishers. (Report)

59. McDaniel JG. Improving system quality through software evaluation. *Comput.Biol.Med* 2002;**32**:127-40.

60. ERDIP Programme, NHS Information Authority. Evaluation of Electronic Patient and Health Record Projects. Heathfield, H. A., Felton, D., and Clamp, S. 2001-IA-533, 1-80. 2002. England, ERDIP Programme, NHS Information Authority. (Report)

61. Kushniruk AW, Patel VL, Cimino JJ. Usability testing in medical informatics: cognitive approaches to evaluation of information systems and user interfaces. *Proc.AMIA.Annu.Fall.Symp.* 1997;218-22.

62. Rubin J. Handbook of usability testing : how to plan, design, and conduct effective tests. New York: Wiley, 1994.

63. Moehr JR. Evaluation of health information systems: beyond efficiency and effectiveness. *Computers in Biology and Medicine* 2002;**32**:111-2.

64. Burkle T, Ammenwerth E, Prokosch HU, Dudeck J. Evaluation of clinical information systems. What can be evaluated and what cannot? *J Eval.Clin Pract.* 2001;**7**:373-85.

65. Anderson JG, Aydin CE, Jay SJ. Evaluating Health Care Information Systems. SAGE, 1994.

66. Mitchell E,.Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980-97. *BMJ* 2001;**322**:279-82.

67. Dick R,.Andrew W. Explosive growth in CPRs: evaluation criteria needed. *Healthc.Inform.* 1995;**12**:110, 112, 114.

68. Garrett, C. and Slaughter, L. QUIS - Questionnaire for User Interaction Satisfaction http://lap.umd.edu/q7/quis.html Last updated 2003 Last accessed 2-7-0003

69. Lee F, Teich JM, Spurr CD, Bates DW. Implementation of physician order entry: user satisfaction and self- reported usage patterns. *J.Am.Med.Inform.Assoc.* 1996;**3**:42-55.

70. Heggland, J OntoLog http://www.idi.ntnu.no/~heggland/ontolog/ Last updated 2003 Last accessed 14-7-0003

71. Kirwan B, Ainsworth LK. A Guide to task analysis. London.: Taylor & Francis., 1992.

72. Denscombe M. The good research guide for small-scale social research projects. Buckingham: Open University Press, 1998.

73. Fink A. The Survey kit / series editor Arlene Fink. Thousand Oaks, Calif.: Sage Publications., 1995.

74. Fayers PM, Machin D. Questionnaire development and scoring. *Quality of life - assessment, analysis and interpretation*, pp 135-52. Chishester: John Wiley, 2000.

75. Keller SD, Ware JE, Jr., Gandek B, Aaronson NK, Alonso J, Apolone G *et al*. Testing the equivalence of translations of widely used response choice labels: results from the IQOLA Project. International Quality of Life Assessment. *J Clin Epidemiol* 1998;**51**:933-44.

76. Rossi PH, Wright JD, Anderson AB. Handbook of survey research. Orlando: Academic Press, 1983.

77. Haraldsen G. Spørreskjemametodikk : etter kokebokmetoden. Oslo: Ad Notam Gyldendal, 1999.

78. Alreck PL, Settle RB. Gathering interview data. In Alreck PL, Settle RB, eds. *The survey research handbook*, pp 210-35. Chicago: Irwin, 1995.

79. Sheatsley PB. Questionnaire Construction and Item writing. In Rossi PH, Wright JD, Anderson AB, eds. *Handbook of survey research*, pp 195-230. Orlando: Academic Press, 1983.

80. Fayers PM, Machin D. Quality of life - assessment, analysis and interpretation. Chishester: John Wiley, 2000.

81. Sittig DF, Kuperman GJ, Fiskio J. Evaluating physician satisfaction regarding user interactions with an electronic medical record system. *Proc.AMIA.Symp.* 1999;400-4.

82. Kirakowski, J. SUMI - Software Usability Measurement Inventory http://www.ucc.ie/hfrg/questionnaires/sumi/index.html Last updated 9-4-2002 Last accessed 2-7-2003

83. Hochstim JR. A Critical Comparison of 3 Strategies of Collecting Data from Households. *Journal of the American Statistical Association* 1967;**62**:976-89.

84. Kahn RL, Cannell CF. The dynamics of interviewing theory, technique, and cases. New York: Wiley, 1957.

85. Dreyfus HL. Mind over machine : the power of human intuition and expertise in the era of the computer. Oxford: Basil Blackwell, 1986.

86. Young DW. What Makes Doctors Use Computers?: Discussion Paper. In Jay SJ, Anderson JG, eds. *Use and impact of computers in clinical medicine*, pp 8-13. New York: Springer-Verlag, 1987.

87. Kushniruk AW,.Patel VL. Cognitive computer-based video analysis: its application in assessing the usability of medical systems. *Medinfo* 1995;**8 Pt 2**:1566-9.

88. Nelson EC, Jacobs AR, Breer PE. A study of the validity of the task inventory method of job analysis. *Med.Care* 1975;**13**:104-13.

89. Kaplan B. The Influence of Medical Values and Practices on Medical Computer Applications. In Jay SJ, Anderson JG, eds. *Use and impact of computers in clinical medicine*, pp 39-49. New York: Springer-Verlag, 1987.

90. Anderson JG, Jay SJ, Schweer HM, Anderson MM. Why Doctors Don't Use Computers: Some Empirical Findings. In Jay SJ, Anderson JG, eds. *Use and impact of computers in clinical medicine*, pp 97-104. New York: Springer-Verlag, 1987.

91. Doll WJ,.Torkzadeh G. The measurement of end-user computing satisfaction. *MIS Quarterly* 1988;**12**:259-74.

92. Aydin CE,.Rice RE. Social worlds, individual-differences, and implementation - predicting attitudes toward a medical information-system. *Information & Management* 1991;**20**:119-36.

93. Sutcliffe A. Task-related information analysis. *International Journal of Human-Computer Studies* 1997;**47**:223-57.

94. Diaper D. Task Analysis for Knowledge Descriptions (TAKD): the method and an example. In Diaper D, ed. *Task analysis for human-computer interaction*, Chichester.: Ellis Horwood., 1989.

95. Fafchamps D, Young CY, Tang PC. Modelling work practices: input to the design of a physician's workstation. *Proc.Annu.Symp.Comput.Appl.Med.Care* 1991;788-92.

96. Sittig DF. Work-sampling: a statistical approach to evaluation of the effect of computers on work patterns in healthcare. *Methods Inf.Med.* 1993;**32**:167-74.

97. Bricon-Souf N, Renard JM, Beuscart R. Dynamic workflow model for complex activity in intensive care unit. *Int.J.Med.Inf.* 1999;**53**:143-50.

98. Jacoby I,.Kindig D. Task analysis in National Health Service Corps field stations: a methodological evaluation. *Med.Care* 1975;**13**:308-17.

99. Cork RD, Detmer WM, Friedman CP. Development and initial validation of an instrument to measure physicians' use of, knowledge about, and attitudes toward computers. *J.Am.Med.Inform.Assoc.* 1998;**5**:164-76.

100. Mendenhall RC, Lloyd JS, Repicky PA, Monson JR, Girard RA, Abrahamson S. A national study of medical and surgical specialties. II. Description of the survey instrument. *JAMA* 1978;**240**:1160-8.

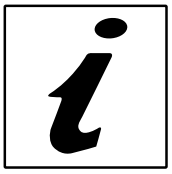
101. Fink A. The Survey kit. Thousand Oaks, CA: Sage Publications., 1995.

102. Alreck PL, Settle RB. The survey research handbook. Chicago: Irwin, 1995.

103. Altman DG. Practical Statistics for Medical Reserach. London: Chapman & Hall/CRC, 1991.

104. Ringdal K. Enhet og Mangfold - Samfunnsvitenskapelig forskning og kvantitativ metode. Bergen: Fagbokforlaget, 2001.

# PAPERS I-IV



# Information in practice

## Doctors' use of electronic medical records systems in hospitals: cross sectional survey

Hallvard Lærum, Gunnar Ellingsen, Arild Faxvaag

Kvalis project, Department of Physiology and Biomedical Engineering, Faculty of Medicine, NTNU, Trondheim, Norway

Hallvard Lærum *fellow*

Kvalis project, Department of Computer and Information Science, Faculty of Physics, Informatics, and Mathematics, NTNU, Trondheim

Gunnar Ellingsen *fellow*

Department of Bone and Joint Disorders, Faculty of Medicine, NTNU, Trondheim

Arild Faxvaag *associate professor*

Correspondence to: Hallvard Lærum, 5.et.kreftbygget, Regionsykehuset i Trondheim, 7006 Trondheim, Norway hallvard.larum@medisin.ntnu.no

*BMJ* 2001;323:1344–8

## Abstract

**Objectives** To compare the use of three electronic medical records systems by doctors in Norwegian hospitals for general clinical tasks.
**Design** Cross sectional questionnaire survey. Semistructured telephone interviews with key staff in information technology in each hospital for details of local implementation of the systems.
**Setting** 32 hospital units in 19 Norwegian hospitals with electronic medical records systems.
**Participants** 227 (72%) of 314 hospital doctors responded, equally distributed between the three electronic medical records systems.
**Main outcome measures** Proportion of respondents who used the electronic system, calculated for each of 23 tasks; difference in proportions of users of different systems when functionality of systems was similar.
**Results** Most tasks listed in the questionnaire (15/23) were generally covered with implemented functions in the electronic medical records systems. However, the systems were used for only 2-7 of the tasks, mainly associated with reading patient data. Respondents showed significant differences in frequency of use of the different systems for four tasks for which the systems offered equivalent functionality. The respondents scored highly in computer literacy (72.2/100), and computer use showed no correlation with respondents' age, sex, or work position. User satisfaction scores were generally positive (67.2/100), with some difference between the systems.
**Conclusions** Doctors used electronic medical records systems for far fewer tasks than the systems supported.

## Introduction

Electronic medical records systems are starting to be used in hospitals throughout Europe. However, there seem to have been few formal evaluations of them,[1 2] possibly because of a lack of established evaluation methods.[3 4] We therefore investigated the usefulness of different systems by comparing their use in general clinical tasks. Frequency of use is a possible indicator of how well such systems are adapted to clinical work in general[5 6] because a successful system ought to be used by most doctors for important tasks.[7] We developed a questionnaire to investigate and compare the use of electronic medical records systems among doctors in Norwegian hospitals.

## Participants and methods

### Electronic medical records systems in Norwegian hospitals

Of the 72 hospitals in Norway, 53 had purchased a licence for an electronic medical records system by January 2001, covering 77% of hospital beds. In practice, there were three main electronic medical records systems—DIPS, Infomedix, and DocuLive (table). The DocuLive system is installed in the five university hospitals and hence is associated with the largest hospitals in the country. None of the largest hospitals had completed implementing the electronic medical records system in all of their departments at the time of our survey.

### Developing the questionnaire

The questionnaire consisted of eight sections (see bmj.com for details). In the section covering use of computers, we generated the list of clinical tasks on the

Distribution of electronic medical records systems in Norwegian hospitals by January 2001, and respondents in survey. Values are numbers (percentages)

| | Nationwide | | | In survey | | |
|---|---|---|---|---|---|---|
| Records system (vendor) | Hospitals (n=72) | Hospital beds (n=13 751) | Doctors (n=6700) | Respondents (n=227) | Hospitals (n=19) | Hospital units (n=32) |
| DIPS (DIPS) | 23 (32) | 2336 (17) | 912 (14) | 69 (31) | 6 | 11 |
| DocuLive EPR (Siemens AG) | 9 (13) | 4375 (32) | 2829 (42) | 77 (33)* | 6* | 9* |
| Infomedix (EMS) | 20 (28) | 3844 (28) | 1550 (23) | 81 (36) | 7 | 12 |
| Other | 1 (1) | 12 (0.1) | 2 (0.03) | 0 | 0 | 0 |
| None | 19 (26) | 3184 (23) | 1407 (21) | 0 | 0 | 0 |

Hospital data from SAMDATA 1999 www.samdata.sintef.no

*Two hospital units in two hospitals represented by eight respondents were excluded post hoc.

P+

*The study questionnaire and details of minimal requirements for electronic medical records systems appear on bmj.com*

basis of 40 hours of observations in five hospital sections at two hospitals, taking into account the information needs of doctors.[8] The section asked doctors to indicate their frequency of use of computers for 23 general clinical tasks on a five point scale ranging from "Never or almost never" to "Always or almost always." In addition, they were asked to indicate whether they were using the implemented electronic medical records system or another computer program (or both) for each task.

We adapted existing, validated questionnaires to produce the sections covering computer literacy[9] and user satisfaction.[10 11]

**Selection of participants, data gathering, and analysis**

We randomly selected 32 hospital units (each with 4-22 doctors) in 19 of the hospitals with a licence for an electronic medical records system grouped by vendor. We excluded very small (<4 doctors) and very large units (>30 doctors) and those that had recently implemented an electronic medical records system (<3 months before). We distributed 314 questionnaires to doctors on 12 January 2001 and sent 134 reminders one month later.

The completed questionnaires were scanned with Teleform, and the data were analysed with SPSS for Windows version 10.0.8. We categorised the doctors' graded responses on their use of computers for general clinical tasks into two groups—those who used a computer for a certain task for at least half of the time normally spent on the task, and those who did not. The respondents who did use the computer for a certain task were further grouped by whether they used the electronic medical records system, another program, or both. However, some respondents (median 7%) did not state what program they used; we do not know whether these respondents overlooked the items or could not tell what software they were using.

**Interviews with information technology staff**

Key representatives of the 19 hospitals' information technology departments, involved in implementing the local electronic medical records, indicated through semistructured telephone interviews whether each clinical task in the questionnaire was supported locally according to certain minimal requirements (see bmj.com for details).

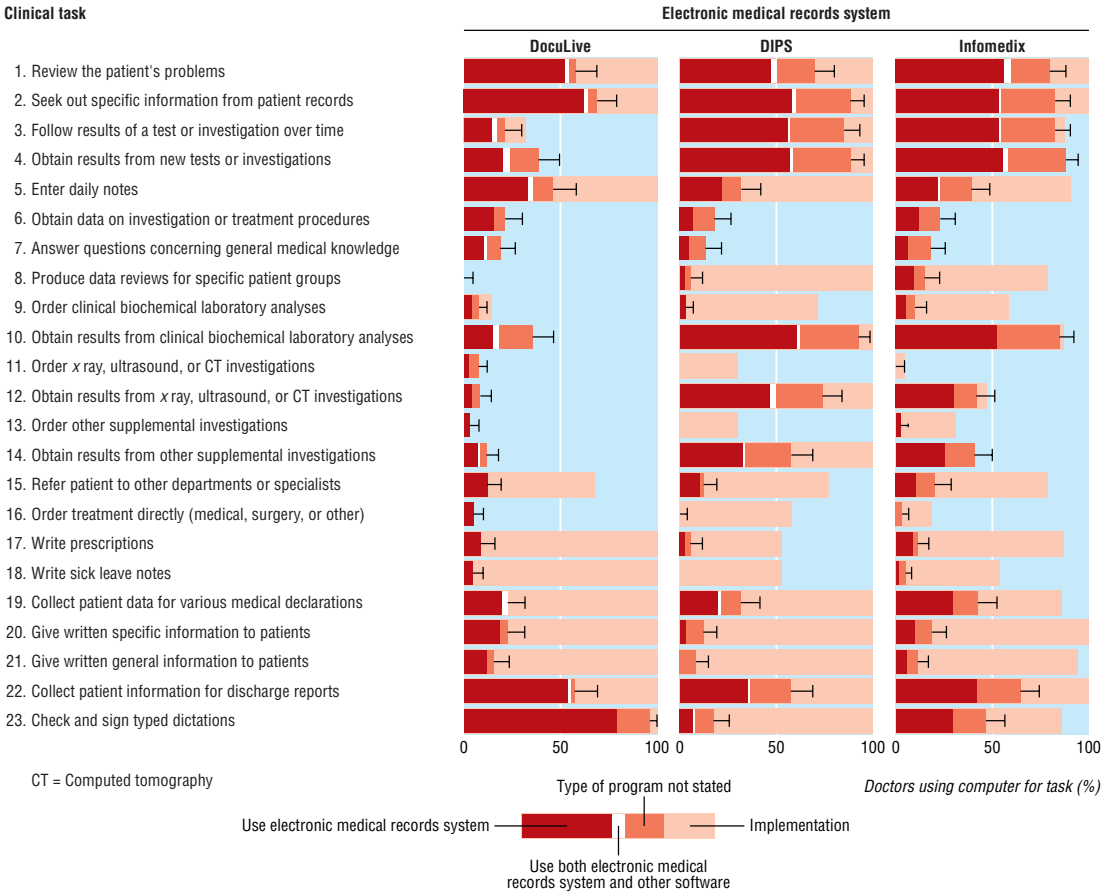



**Fig 1** Reported use of computer programs for various clinical tasks by doctors from hospitals with different electronic medical records systems. Bars represent percentage of doctors who reported using computers at least half of the time for performing each task (red areas show those who used only the electronic medical records system, white areas show those who used the system and other software, and orange areas show those who did not state what program they used) and error bars show the confidence interval. Pink bars in background show percentage of respondents for whom the electronic medical records systems offered sufficient functionality for the task

## Results

### Respondent demographics showed no effect on computer use

The response rate to our questionnaire was 72%, but we subsequently excluded two hospital units (eight respondents) because of problems with their implementing the electronic medical records system, leaving 219 respondents. Of the 208 who answered the question, 47 (23%) were less than 35 years old, 98 (47%) were aged 35-50, and 63 (30%) were aged over 50; 57/197 (29%) were women, and 140 (71%) were men; 123/205 (60%) were consultants, 74 (36%) were registrars, and eight (4%) were senior house officers. There was no significant difference between different electronic medical records systems in terms of respondents' age, sex, or work position, nor any correlation between these terms and total computer use or user satisfaction.

### Respondents scored high in computer literacy

To assess respondents' computer literacy we asked them about their computer ownership, typewriting ability, prior computing experience in solving specific tasks, highest prior frequency of computer use, and self rated computing skills. The mean summed score of this section was 72.2 out of 100, with little difference between the users of the three electronic medical records systems (69.6-76.0, analysis of variance P=0.006). The correlation with total computer use was 0.39, $P < 0.001$.

### Computers were available in the respondents' work places

Most respondents (203/218 (93%)) had computers in their offices, and 209/216 (97%) had computers available to them in other rooms used for clinical work. However, 85/214 respondents (40%) were weekly or daily prevented from using these computers because others were using them, and 94/214 (44%) were monthly or weekly hindered by computer errors or problems with passwords (3% were hindered daily).

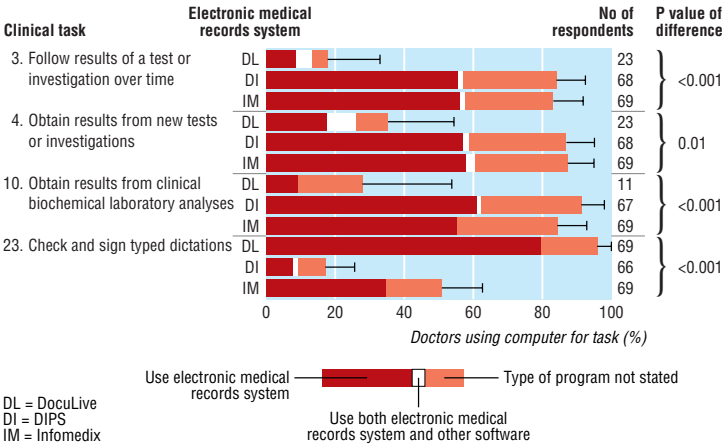



**Fig 2** Clinical tasks for which significantly different percentages of doctors reported using three different electronic medical records systems that offered equivalent functionality. Bars represent percentage of doctors who reported using computers at least half of the time for performing each task (red areas show those who used only the electronic medical records system, white areas show those who used the system and other software, and orange areas show those who did not state what program they used) and error bars show the confidence interval. P values were calculated with $\chi^2$ formula (equal P values were achieved with analysis of red areas of bars only and when white and orange areas were included).

### Use of the electronic medical records systems was limited

*Functionality of the electronic medical records systems*

According to the information provided by information technology staff, most of the clinical tasks listed in our questionnaire were in some way covered by implemented functions of the electronic medical records systems. In general, 15 of the 23 tasks were covered for at least half of respondents: DIPS, Infomedix, and DocuLive supported 19, 16, and 11 of the tasks, respectively (fig 1).

*The systems were mainly used for reading patient data*

Only two tasks (tasks 1 and 2 on fig 1) were performed with the electronic records systems by at least half of the respondents. When we included those respondents who did not indicate what type of computer program they used, the number of tasks rose to seven (tasks 1-4, 10, 22, and 23). The median proportion of respondents using programs other than the electronic medical records systems was 2% (interquartile range 1-5%); the highest proportions occurred in tasks where some of the records systems were particularly lacking in functionality (tasks 4, 7, and 10).

The number of tasks for which each respondent used an electronic records system was similar for each of the systems (mean number of tasks: DIPS 4.9, DocuLive 4.9, Infomedix 5.2; analysis of variance P=0.87). Only when we included those respondents who did not indicate what type of computer program they used did we find significant differences (DIPS 7.4, DocuLive 5.7, InfoMedix 7.8; analysis of variance P=0.002).

*Considerable differences between systems in specific use*

We found considerable differences in doctors' use of the electronic medical records systems when we compared respondents who were offered similar functionality (fig 2). Because of some functionality not being implemented locally, the groups of respondents are smaller than in figure 1, particularly for the DocuLive system.

### Moderate user satisfaction

The user satisfaction scale consisted of five factors: content, accuracy, format, ease of use, and timeliness.[11] The mean overall score was 67.2 (SD 13.8) out of 100 (mean score for each factor: 56.9, 73.4, 70.4, 64.4, and 66.6, respectively). The DocuLive system scored significantly worse than the others (overall score 61.4 *v* 69.8 for DIPS and 69.7 for Infomedix; analysis of variance P=0.001), particularly in the content factor. The correlation of satisfaction with total computer use was 0.39 ($P < 0.001$).

## Discussion

Despite widespread implementation of electronic medical records systems in Norwegian hospitals, our results reveal a low level of use of all three electronic medical records systems by doctors, especially in the largest hospitals. The systems were mainly used for reading patient data, and doctors used the systems for less than half of the tasks for which the systems were functional. Among these unused functions were repetitive tasks such as writing prescriptions, which are apparently well suited for computers.

Essentially the same findings applied to all three systems, which suggests that similar results might be found in other countries. When the impact of an electronic medical records system is investigated, we suggest that its actual use should be considered rather than its claimed functionality.

**Limitations of the survey**

Our survey covered only doctors, but other healthcare workers probably also use the electronic medical records systems. We did not assess how frequently the various clinical tasks were performed nor how time consuming they were, making it difficult to weight them. Self reporting carries a risk of misinterpretation and bias, even when "value neutral" behaviour is investigated. Finally, the distinction between using the electronic patient records system and using a different computer application might not always have been clear to doctors.

**Possible reasons for low level of use of electronic medical records systems**

*Access to computers and computer literacy*

The low level of electronic medical records system use could be explained by a lack of available computers. This would, however, affect the use for all clinical tasks in a uniform manner. In addition, the majority of respondents reported that they had some computers available to them both in their offices and in the ward. The section covering computer literacy showed high scores, indicating at least a basic knowledge of computers. However, we cannot rule out potential unmet needs for specific training in electronic medical records system usage.

*Flexibility of paper records*

Paper based patient records are still in daily use in Norwegian hospitals. Thus the respondents could choose whether to use the electronic medical records systems. In some situations it might be more convenient to use paper records, such as for writing short prescriptions, spreading records on a table, or carrying documents around. Until a proper level of electronic integration is achieved, paper record will remain the most complete information source. In addition, the usefulness of an electronic records system for manipulating large amounts of data will not be apparent until historical information has accumulated for some time.

*Traditional work routines*

Our general findings of computer use conform to the traditional division of labour in hospitals—with writing (task 5) associated with secretaries, mediation of requests (tasks 9,11, and 13) associated with nurses, and reading associated with doctors. None of the electronic medical records systems seem to have stimulated the development of new or more advantageous ways of doing medical work,[12] they have simply reinforced existing routines. This indicates that technology alone is not sufficient to achieve a well functioning electronic information system; organisational aspects must also be taken into account.

Working in new ways and performing tasks normally done by other professions often means disruption to established work roles, which may lead to local resistance.[13] Staff who take on extra duties do not necessarily enjoy the benefits of more efficient work patterns, and new reward systems may be needed for acceptance of new work roles.

**What is already known on this topic**

Electronic information systems in health care have not undergone systematic evaluation, and few comparisons between electronic medical records systems have been made

Given the information intensive nature of clinical work, electronic medical records systems should be of help to doctors for most clinical tasks

**What this study adds**

Doctors in Norwegian hospitals reported a low level of use of all electronic medical records systems

The systems were mainly used for reading patient data, and doctors used the systems for less than half of the tasks for which the systems were functional

Analyses of actual use of electronic medical records provide more information than user satisfaction or functionality of such records systems

**Differences between electronic medical records systems**

We found considerable differences in the frequency of use of the three record systems for certain clinical tasks (fig 2). DocuLive was often used for checking and signing, indicating that doctors were using it, but it was used much less than the other two systems for other tasks (3, 4, and 10). A possible explanation for this is the degree of integration with other computer software. Infomedix and DIPS were predominately installed in smaller hospitals, where the same vendor often supplied any other computer modules used, simplifying integration. DocuLive was introduced in the largest hospitals, where the organisational complexity is greatest and where many independent information systems already exist, making it difficult to develop an integrated information system.[14]

We thank Eric Monteiro for excellent guidance, Stewart Clarke and Bernard Evans for help with translating the questionnaire, Turi Saltnes for expert help with questionnaire design and scanning, Peter Fayers and Eirik Skogvoll for experienced statistical advice, and Lars Aabakken for professional support.

Contributors: HL and GE gathered background information on implementations of electronic medical record systems, and HL gathered background information on hospitals. HL and GE performed the observational fieldwork, and HL, GE, and AF defined the content of the questionnaire. HL designed the questionnaire, coordinated its translation, programmed the database, and registered the hospital data. GE and HL performed randomisation, information gathering on each hospital unit, and follow up for successful inclusion. HL distributed, scanned, and statistically analysed the questionnaires and interviewed information technology staff by telephone. HL, GE, and AF jointly wrote the manuscript. HL is guarantor for the study.

Funding: This investigation is funded by the Research Council of Norway through the Kvalis project (http://kvalis.ntnu.no).

Competing interests: None declared.

1 Heathfield HA, Pitty D, Hanka R. Evaluating information technology in health care: barriers and challenges. *BMJ* 1998;316:1959-61.
2 Mitchell E, Sullivan F. A descriptive feast but an evaluative famine: systematic review of published articles on primary care computing during 1980-97. *BMJ* 2001;322:279-82.
3 Dick R, Andrew W. Explosive growth in CPRs: evaluation criteria needed. *Healthc Inform* 1995;12:110, 112, 114.
4 Friedman CP, Wyatt JC. Challenges of evaluation in medical informatics. *Evaluation methods in medical informatics*. New York: Springer, 1997:1-12.
5 Cork RD, Detmer WM, Friedman CP. Development and initial validation of an instrument to measure physicians' use of, knowledge about, and attitudes toward computers. *J Am Med Inform Assoc* 1998;5:164-76.
6 Sittig DF, Kuperman GJ, Fiskio J. Evaluating physician satisfaction regarding user interactions with an electronic medical record system. *Proc AMIA Symp* 1999;400-4.
7 Chin HL, McClure P. Evaluating a comprehensive outpatient clinical information system: a case study and model for system evaluation. *Proc Annu Symp Comput Appl Med Care* 1995;717-21.
8 Gorman PN. Information needs of physicians. *J Am Soc Inf Sci* 1995;46:729-36.
9 Brown SH, Coney RD. Changes in physicians' computer anxiety and attitudes related to clinical information system use. *J Am Med Inform Assoc* 1994;1:381-94.
10 Aydin CE, Rice RE. Social worlds, individual differences, and implementation—predicting attitudes toward a medical information system. *Inf Manage* 1991;20:119-36.
11 Doll WJ, Torkzadeh G. The measurement of end-user computing satisfaction—theoretical and methodological issues. *Miss Q* 1991;15:5-10.
12 Bates DW, Teich JM, Lee J, Seger D, Kuperman GJ, Ma'luf N, et al. The impact of computerized physician order entry on medication error prevention. *J Am Med Inform Assoc* 1999;6:313-21.
13 Heeks R, Mundy D, Salazar A. *Why health care information systems succeed or fail*. Manchester: Institute for Development Policy and Management, 1999. (Information Systems for Public Sector Management working paper 9.)
14 Grimson J, Grimson W, Berry D, Stephen G, Felton E, Kalra D, et al. A CORBA-based integration of distributed electronic healthcare records using the synapses approach. *IEEE Trans Inf Technol Biomed* 1998;2:124-38.

*(Accepted 12 October 2001)*

## INFOPOINTS

### *IER—an educational resource for health informatics in general practice*

*The New NHS* sets a premium on high quality information to support patient care.[1] This requirement has been recognised through the publication of NHS strategy documents on information.[2 3] Emerging from these policy initiatives is the need for high quality health data accessible through electronic patient record systems.[4] The quality of general practice data will underpin clinical care, practice payments, clinical governance, assessment of health needs, commissioning, and even professional reaccreditation. These policy initiatives have been accompanied by the emergence of the new discipline of health informatics in the academic curriculum and a clear need to develop training in informatics.[5]

The Informatics Educational Resource (IER) is a set of resources designed to support learning and teaching in health informatics. The material has been developed iteratively, taking feedback from several sources. Originally prepared for general practitioner registrars in Yorkshire, the IER can be used in different contexts throughout the NHS. In the past two years, IER development has been supported by a grant from the Academy of Colleges Information Group. The IER is not a course or a specification for a qualification, but a set of resources that assist different types of learning needs in different contexts. The IER defines what needs to be learnt and taught, provides material that supports this learning, and makes available other material (via links on the IER website).

The IER is one solution to the problems posed by *Learning to Manage Health Information*.[5] It covers all the subjects set out in that document and places additional emphasis on interpersonal communication and use of computers during medical consultations. We use and develop examples of audit in the IER to help trainees develop their informatics skills with "real world" problems. This is one of several pathways through the material. The IER has been modified by feedback from trainees and teachers in the Yorkshire Deanery, and we run an annual course for general practitioner educators in Yorkshire based around the IER material. The IER project and material was presented at the London conference of the Academy of Colleges Information Group ("Learning to manage health information practically") in September 2000.[6]

We believe that the IER provides a framework for teaching health informatics in a variety of settings. We stress that health informatics skills are an integral part of clinicians' everyday working practice and informatics is (at least) as much about person to person communication as it is about technical skills. We recommend that

- Efforts are made to encourage the inclusion of health informatics in all parts of medical curriculums (undergraduate and postgraduate) in all specialties
- Interpersonal skills are taught alongside information handling and information transfer
- Special attention is paid to the needs of clinicians who are currently in post
- Consideration is given to the role of clinicians in an information rich society.

The IER website (**http://128.240.23.108/eprval/**) is hosted by the Sowerby Centre for Health Informatics in Newcastle (SCHIN).

Alan Hassey *general practitioner*

Fisher Medical Centre, Millfields, Skipton BD23 1EU
(alan.hassey@btinternet.com)

Paul Robinson *general practitioner*

The Surgery, Snainton, Scarborough YO13 9AF

Funding: The IER was developed with the help of a grant from the Academy of Colleges Information Group (ACIG). The Fisher Medical Centre receives "Support for science" funding from Northern and Yorkshire Region of the NHS Executive.

1 Secretary of State for Health. *The new NHS: modern, dependable*. London: Stationery Office, 1997. (Cm 3807.)
2 NHS Executive. *Information for health: an information strategy for the modern NHS 1998-2005*. Leeds: NHS Executive, 1998.
3 Department of Health. *Building the information core: implementing the NHS Plan*. London: DoH, 2001.
4 NHS Information Authority. PRIMIS (Primary Care Information Services). www.primis.nottingham.ac.uk/ (accessed 22 Oct 2001).
5 Severs M, Pearson S. *Learning to manage health information: a theme for clinical education*. Bristol: NHS Executive (South and West), 1999.
6 Academy of Colleges Information Group. *Conference report: Learning to manage health information practically*. London: ACIG, 2000. (http://www.aomrc.org.uk/V2acig.pdf)

*BMJ* 2001;323:1348

*Research Paper* ■

# Effects of Scanning and Eliminating Paper-based Medical Records on Hospital Physicians' Clinical Work Practice

HALLVARD LÆRUM, MD, TOM H. KARLSEN, MD, ARILD FAXVAAG, MD, PHD

**Abstract** **Objective:** It is not automatically given that the paper-based medical record can be eliminated after the introduction of an electronic medical record (EMR) in a hospital. Many keep and update the paper-based counterpart, and this limits the use of the EMR system. The authors have evaluated the physicians' clinical work practices and attitudes toward a system in a hospital that has eliminated the paper-based counterpart using scanning technology.

**Design:** Combined open-ended interviews (8 physicians) and cross-sectional survey (70 physicians) were conducted and compared with reference data from a previous national survey (69 physicians from six hospitals). The hospitals in the reference group were using the same EMR system without the scanning module.

**Measurements:** The questionnaire (English translation available as an online data supplement at www.jamia.org) covered frequency of use of the EMR system for 19 defined tasks, ease of performing them, and user satisfaction. The interviews were open-ended.

**Results:** The physicians routinely used the system for nine of 11 tasks regarding retrieval of patient data, which the majority of the physicians found more easily performed than before. However, 22% to 25% of the physicians found retrieval of patient data more difficult, particularly among internists (33%). Overall, the physicians were equally satisfied with the part of the system handling the regular electronic data as that of the physicians in the reference group. They were, however, much less satisfied with the use of scanned document images than that of regular electronic data, using the former less frequently than the latter.

**Conclusion:** Scanning and elimination of the paper-based medical record is feasible, but the scanned document images should be considered an intermediate stage toward fully electronic medical records. To our knowledge, this is the first assessment from a hospital in the process of completing such a scanning project.

■ **J Am Med Inform Assoc.** 2003;10:588–595. DOI 10.1197/jamia.M1337.

The electronic medical record (EMR) is considered a prerequisite for the efficient storage, distribution, and use of patient data in hospitals.[1] The development and implementation of EMR systems that have the capability of storing and presenting all the information contained in a typical paper-based medical record have, however, proven to be complex tasks.[2–5] In Norway, systems with the ability of storing a proportion of the information in the paper-based medical record are implemented in most hospitals.[6] Until recently, Norwegian legislation has made it necessary to maintain the paper-based medical records, resulting in a combined electronic and paper-based medical record best described as a hybrid (Fig. 1). In this situation, the EMR systems are of limited value to physicians.[6]

A revised legislation, enacted in January 2001, defines criteria for how the patient data can be stored solely in an electronic format. However, to obtain a complete record, several paper-based sources of patient data must be converted to a digital format without loss of medical or legal information. This includes the paper-based medical record as well as paper documents that have been created by hand or that stem from diagnostic devices or information systems not integrated with the EMR system. In practice, it means that a complete EMR system must support scanning and storage of documents as images.

Having two complete copies of a medical record is superfluous, and the next logical step is an elimination of the paper-based medical record. Since no alternative system will be available to the physician in case of failure of the computer system, this can be considered a strategy of no return. Such a radical change in work methods carries a risk of full refusal by the clinical staff, as has been reported in previous studies.[7,8] These aspects probably discourage hospitals from taking this next step toward computerization. Although scanning of paper-based medical records in hospitals has been described by others,[9,10] the effects of eliminating them are not known. In

Affiliations of the authors: INM, Faculty of Medicine, NTNU, Trondheim, Norway (HL, AF); Sørlandet Sykehus HF Arendal, Norway (formerly called Aust-Agder Sykehus HF) (THK).

The authors thank Gerd Gulstad, Bjørn Engum, Tom Schulz, Anne-Brit Riiser, and Astrid Norberg for their continued help and support. This investigation is funded by the Norwegian Ministry of Health and the Research Council of Norway through the Kvalis project at the Norwegian University of Science and Technology, Trondheim.

Correspondence and reprints: Hallvard Lærum, MD, DigiMed Centre, Elgesetergate 10, N-7465 Trondheim, Norway; e-mail: <hallvard.larum@medisin.ntnu.no>.

Received for publication: 01/28/03; accepted for publication: 07/16/03.

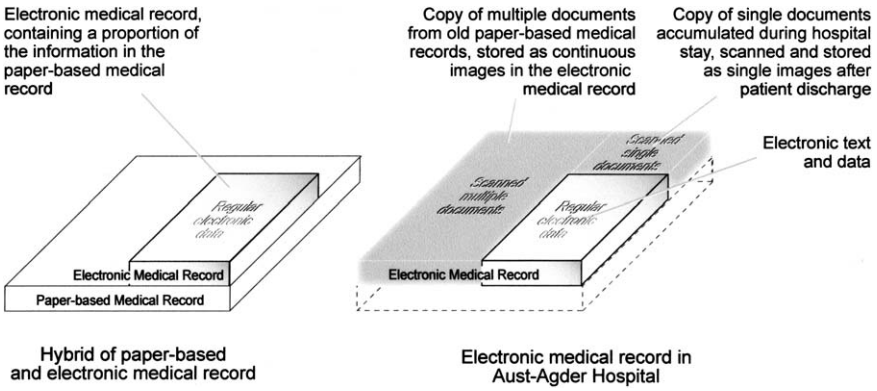



**Figure 1.** Diagram of the medical records in most hospitals (*left*) and in Aust-Agder Hospital (*right*). In the former, the paper-based medical record dominates, being the only complete record. In the latter, there is a complex mix of fully electronic medical records and scanned images of text on paper (single documents and multiple documents in continuous sections).

this report, we have evaluated the effects of scanning and elimination by studying the physicians' reported performance of clinical work tasks and their attitudes toward the system. The findings were compared with that of other hospitals that are using the same system but are not scanning or eliminating the paper-based medical records. To assess these variables, we have used questionnaires, group discussions, and interviews.

## Methods

### Brief Description of the Hospital and the EMR System

Aust-Agder Hospital is a 410-bed community hospital serving a population of 102,000 in Aust-Agder County, southern Norway, caring for 18,600 inpatients and 74,000 outpatients per year (1998). The patients are admitted by primary care physicians external to the hospital and followed up by the hospital physicians. The hospital is comprised of departments for psychiatry; general surgery; internal medicine; orthopedics; gynecology; ear, nose, and throat; and ophthalmology. Well funded, and with a strong commitment by the hospital administration, the hospital staff began implementation of DIPS 2000, a commercially available combined EMR and hospital administrative system (<www.dips.com>) in March 2000. In April 2001, all except the psychiatric department started to scan documents; hence, all new patient data were channeled into the EMR system in these departments. To handle the transition to EMR, a separate project organization had been recruited from the hospital staff. The project organization provided regular class-type training for the users and a network of super users (the most experienced users) among the ward staff. The system was available in 1,100 terminals throughout the hospital, except for the inpatients' rooms.

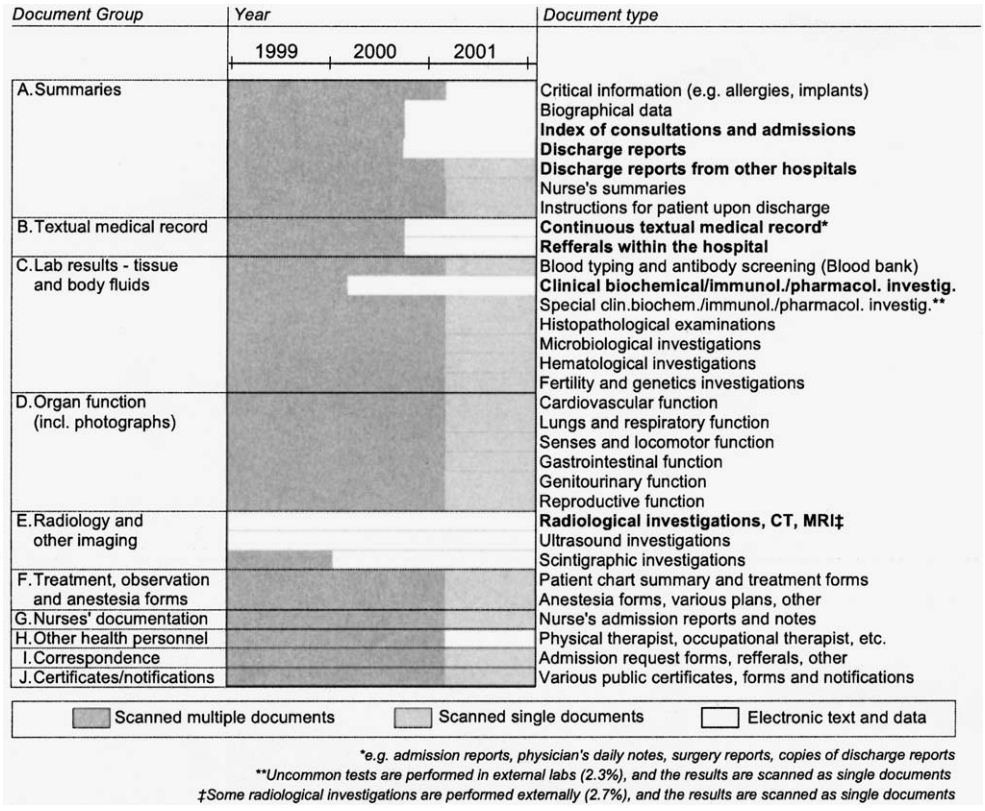



**Figure 2.** Contents of the EMR at Aust-Agder Hospital at the time of the investigation, structured according to the standards defined by the Norwegian Board of Health (<www.helsetilsynet.no>). Essential patient data are repeated commonly in several places, typically in the continuous textual medical record (B). Document types of special importance to physicians are emphasized in bold type. The bars are equal in height and thus do not reflect the relative volumes of the actual content in the EMR.

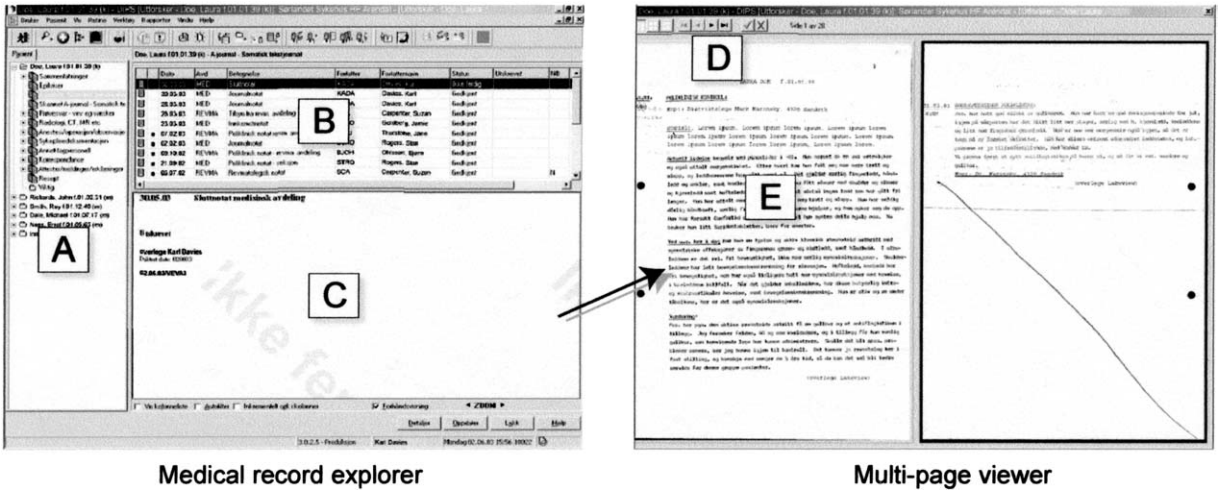



**Figure 3.** Navigation of electronic text and scanned document images. Medical record explorer. (**A**) Hierarchical view of a physician's patients with groups and types of associated documents. (**B**) List of documents of the selected document type. (**C**) Preview of contents. Multipage viewer. (**D**) Navigation buttons (number of pages shown, first, previous, next, last). (**E**) Viewing area showing scanned multiple documents. Screen captures reprinted with permission from DIPS ASA, Norway.

The patient data in the EMR are stored either as searchable text and numbers or as document images. The former, called *regular electronic data*, essentially consist of the chronologic, text-based medical record integrated with laboratory data in numerical form and textual radiology reports (Fig. 2). The latter are divided by structure into two categories, as follows: upon admittance or consultation, the documents in the old paper-based medical records are scanned into the system as digital images in TIFF format. Each image contains all the sheets of one main section of the paper-based record and, hence, corresponds to a whole document group (groups A-J in Fig. 2). These images are called *scanned multiple documents*. Searching in them is essentially done by reading the contents, aided by the dates appearing on the documents (Fig. 3E). Upon patient discharge, various paper sheets accumulated during the stay (e.g., the medical treatment form, printouts from diagnostic devices) are scanned, dated, and labeled by document type singularly (Fig. 2). The resulting images are called *scanned single documents*. Searching in them is assisted by their date labels and the hierarchy of document types. This makes it easier to locate specific information in the scanned single documents than in the scanned multiple documents. In summary, the patient data are stored as regular electronic data, scanned multiple documents, and scanned single documents. They all appear in the hierarchical list in the "medical record explorer" window (Fig. 3A), but are treated separately in this report because of their difference in structure, indexation, and functionality.

After scanning, the paper-based record is destroyed. However, at the time of the investigation, about 50% of inpatients in the surgical department, 75% in the medical department, and 15 to 20% of patients in other departments still had their paper-based medical records intact (Fig. 4). This is because preparing and scanning them was more time-consuming than expected. Hence, elective patients were prioritized, supplemented by a systematic scanning of the archives. Since most patients in the medical department are admitted acutely, more patients in the medical than in the surgical department had their paper-based medical record intact. However, the information found in the paper-based medical records were at least one year old as the study was carried out, as no new information was channeled into them after the onset of the scanning routines. Furthermore, essential information from them (e.g., previous diagnoses, implants, and surgical operations) was cited frequently in textual summaries in the EMR.

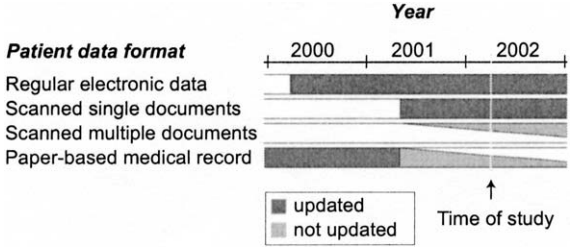



**Figure 4.** Overview of how the patient data have been incorporated into the EMR. After the onset of scanning, the paper-based medical record was no longer updated. The height of the "scanned multiple documents" horizontal bar represents the average percentage of inpatients for which the paper-based medical record had been scanned.

## The Survey

A questionnaire previously used in a national survey[6] was modified according to the functionality offered by the EMR system in Aust-Agder Hospital in cooperation with physicians at the hospital. The questionnaire contained sections on use of EMR for specific tasks, ease of performing the tasks, and user satisfaction concerning detailed aspects of the system[11] and the system as a whole.[12] The essential modifications were omitting questions regarding tasks for which no functionality was implemented in the hospital and providing two full sets of questions on detailed user satisfaction regarding regular electronic data and scanned document images separately. (The questionnaire is available as an online data supplement at www.jamia.org.) From

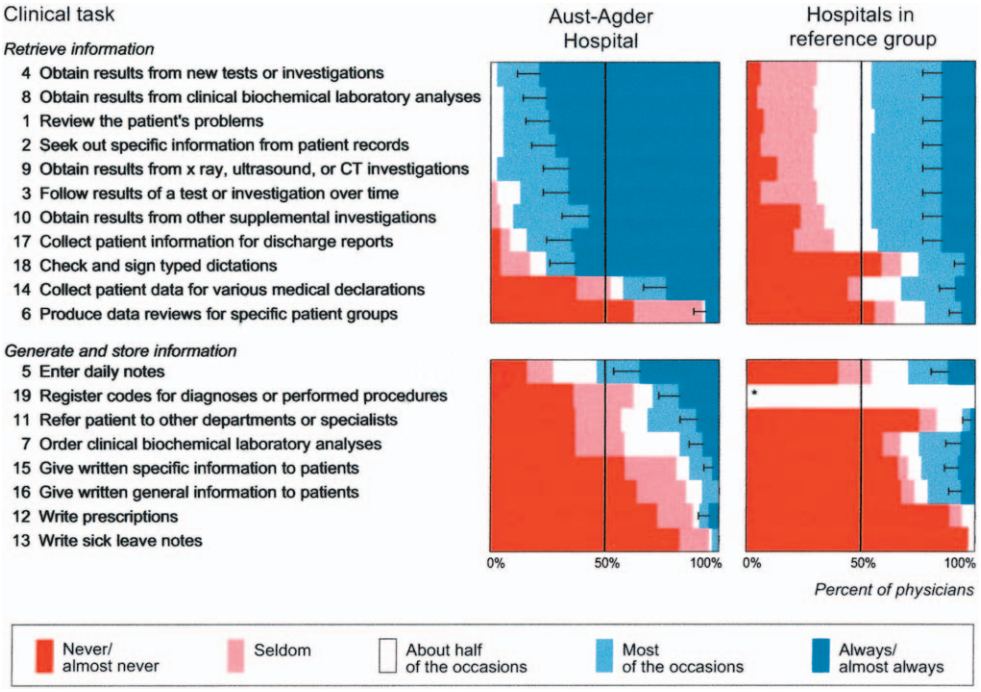



**Figure 5.** Reported frequency of use of the regular EMR for various clinical tasks in Aust-Agder Hospital, compared with that of the hospitals in the reference group.[6] The blue color tones in the figure represent frequent use, and the red color tones represent infrequent use. The error bars show the upper confidence interval limit of the proportion of physicians answering "always or almost always"; the remaining error bars are hidden for clarity. *Data for task 19 are not available in the reference group.

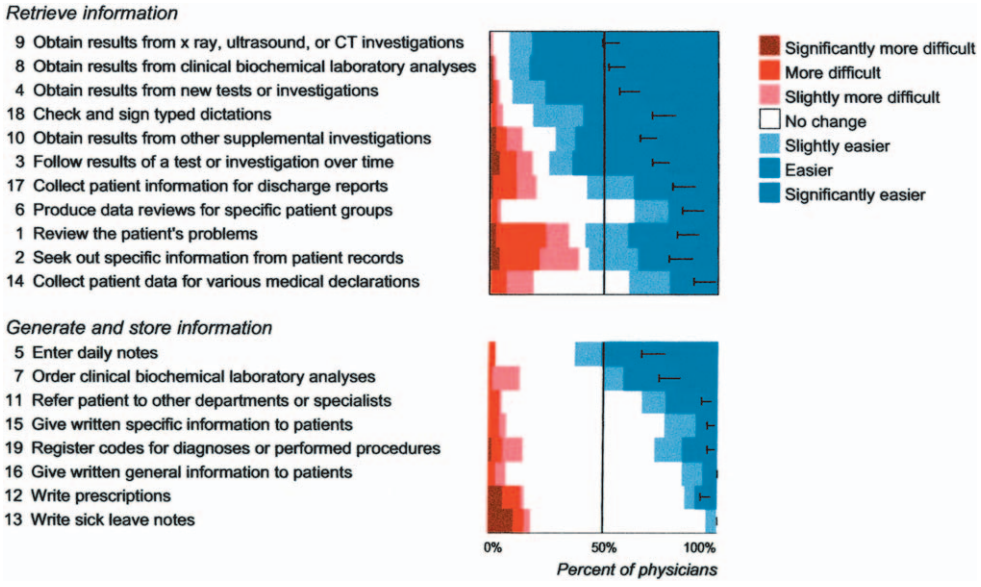



**Figure 6.** Performance of clinical tasks using the EMR system as a whole (including the scanned document images) compared with previous routines. The tasks are placed in upper or lower sections by whether they are mainly related to retrieving information or to generating and storing information, respectively. The tasks are sorted by average response values in descending order within each section. The blue color tones in the figure represent physicians responding that the task has become easier using the system, and the red color tones represent those responding that the task has become more difficult. The error bars show the upper confidence interval limit for the proportion of physicians responding "significantly easier"; the remaining error bars are hidden for clarity.

February through April 2002, the 80 physicians in the medical, surgical, and other departments received the questionnaire. Of these, 70 physicians responded (respectively, 27, 22, and 21), for a total response rate of 88%.

### *The Reference Group*

As a reference group, we selected the responses of all physicians working in hospitals using the same EMR system as that of Aust-Agder Hospital in a national survey

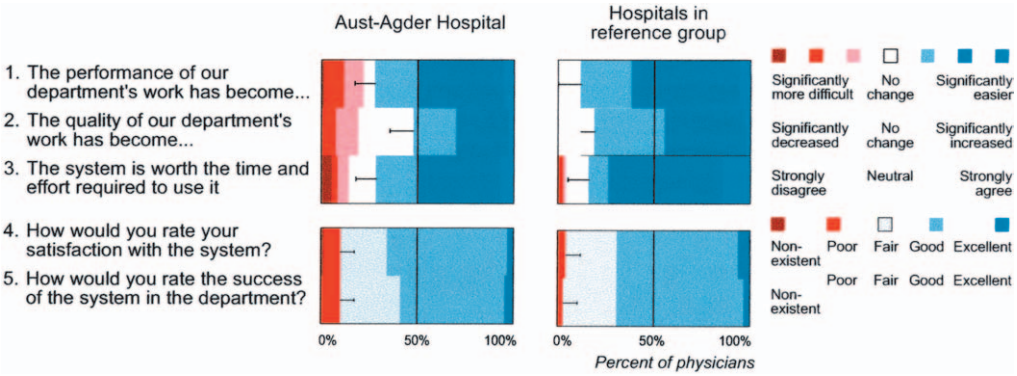



**Figure 7.** User satisfaction with the EMR system as a whole compared with that of physicians in the reference group.[6] The blue tones in the figure represent positive answers, and red tones represent negative answers. The error bars show the upper confidence interval limit of the combined proportion of physicians giving positive answers to each question; the remaining error bars are hidden for clarity.

performed in 2001.[6] The hospitals belonging to the reference group were neither scanning nor eliminating their paper-based medical records. The reference group consisted of 69 physicians from six hospitals, equally distributed between medical, surgical, and pediatric departments (respectively, 20, 24, and 25 physicians), and the response rate in this group was 72% (69 of 96). The reference data regarding use of the EMR system was limited to the respondents for which the defined task was reported as implemented.

### *Analysis and Presentation*

We used Teleform for data acquisition and SPSS 11.0 for Windows for statistical analysis of the survey. One-way analysis of variance was used for comparisons involving the detailed user satisfaction score.[11] This score was calculated by adding the response values of the 12 questions in this section and converting the sum to percent of maximum possible score. The analyses for the rest of the questionnaire were done separately for each question, using the nonparametric analyses Kruskal-Wallis or Mann-Whitney U. These analyses rely on ranks, which are not easily presented. To present the magnitude of the differences without using ranks, we have shown directly in the figures the frequency of each response in every question (Figs. 5–7), providing complex but structured figures.

### Group Discussions and Interviews with Users

After the system was implemented, a group of 15 physicians, nurses, and clerical staff from the medical department spent approximately 40 hours drawing workflow charts of how the clinical work is undertaken in the department. One of the authors interviewed eight physicians for 0.5 to 2 hours, discussing these charts and how the EMR system facilitated the work procedures described here. Comments concerning advantages and disadvantages of the system were noted during the interviews and group discussions, and these comments were summarized. Only the comments from the physicians are presented here.

## Results

The survey and the interviews gave insight into the physicians' use of the EMR system, the ease with which they were performing clinical tasks using the system, and their satisfaction with the system.

### The Regular EMR Was Used Routinely for Information Retrieval

As should be expected, the physicians in Aust-Agder Hospital used the EMR system much more extensively than

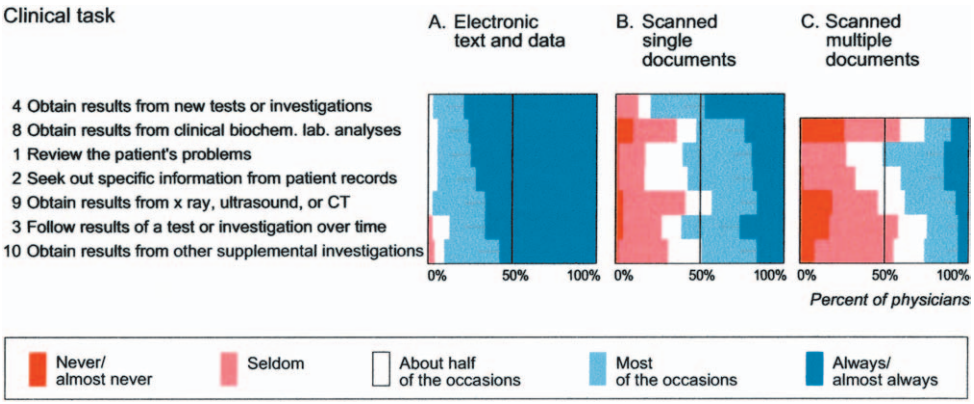



**Figure 8.** The reported frequency of use of various formats of the EMR. The formats are regular electronic data (**A**), scanned single documents (**B**), and scanned multiple documents (**C**). The tasks are sorted in descending order by the average of response values in part A. The blue color tones in the figure represent frequent use, and the red color tones represent infrequent use. The error bars show the upper confidence interval limit of the proportion of physicians answering "always or almost always"; the remaining error bars are hidden for clarity. Task 4 is omitted from part C, as the paper-based medical records in the scanned multiple documents are at least one year old and do not contain results from new tests or investigations.

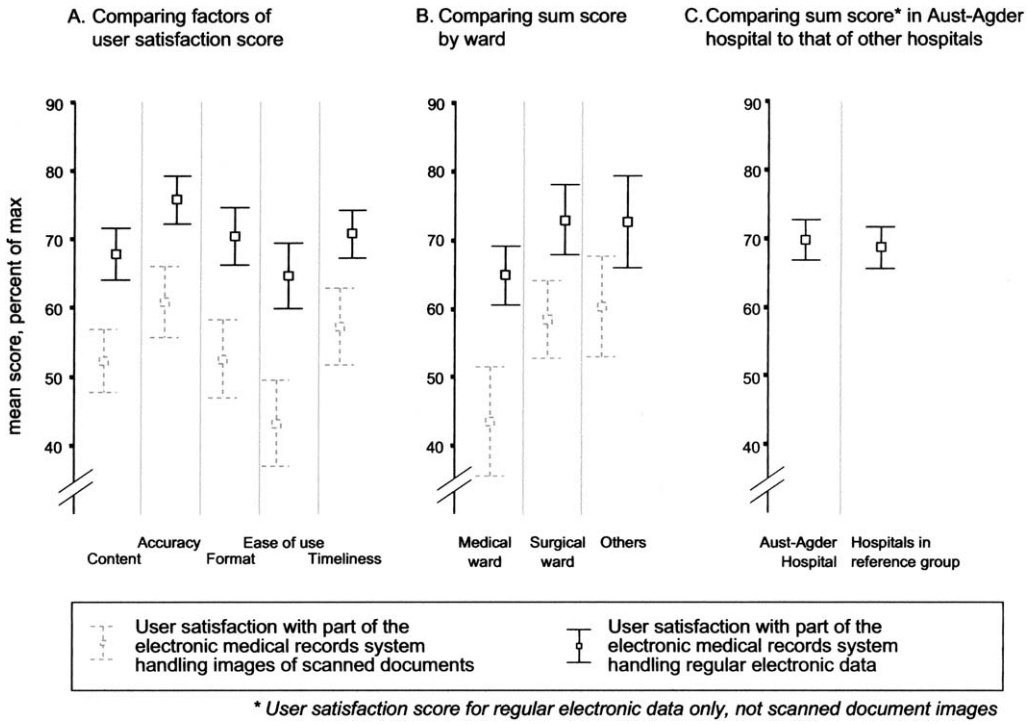



**Figure 9.** User satisfaction with use of the system regarding the two forms of EMR, as scanned document images and as regular electronic data. The graph is divided into three parts. **A** compares the mean score of the two forms of EMR in each of the five factors in the user satisfaction scale. **B** compares the mean user satisfaction score of physicians in various specialties, regarding the two forms of EMR. **C** compares the mean user satisfaction score of all physicians in Aust-Agder Hospital to that of the hospitals in the reference group.[6] Since the hospitals in the reference group do not have the scanning functionality, only the user satisfaction score for the part of the system handling regular electronic data is shown. All error bars show the confidence interval of the mean.

in other hospitals (Fig. 5; Mann-Whitney U; $p<0.05$ in 2 tasks and $p<0.001$ in 10 tasks), however, not for all tasks. The physicians used the system on a routine basis regarding most of the tasks related to information retrieval (Fig. 5; 9 of 11 tasks), but regarding the tasks related to generating and storing information, the system was used only for entering daily notes (task 5). For instance, the physicians preferred not to use the system for writing a prescription or completing a sick leave form, despite the fact that the system supported these tasks.

## Tasks Regarding Information Retrieval Were More Easily Performed by Most Physician Groups

Although the use of the system is important, it is perhaps even more important whether the introduction of the EMR increases the efficiency with which the clinical tasks are performed. For each clinical task in the questionnaire, we asked the physicians whether performing the task in the department had become easier or more difficult using the system as a whole, compared with previous work routines. Regarding tasks related to information retrieval (Fig. 6), the performance of nine of 11 tasks had become easier. Regarding the tasks related to generation and storage of information, the performance of only one of 11 tasks (task 5) had become easier. A considerable proportion of the physicians found that two tasks actually had become more difficult to perform (responding "more difficult" or "significantly more difficult" in tasks 1 and 2, respectively; 24.6% [17 of 69] and 21.7% [15 of 69]). Interestingly, the internists were more negative than the surgeons in these questions. For tasks 1 and 2, only 9.5% (2 of 21) and 4.8% (1 of 21) of the surgeons responded with these alternatives, respectively, while 33.0% (9 of 27) of the internists did so in both tasks (Mann-Whitney U, one-tailed Monte Carlo; $p = 0.05$ and $p = 0.01$, respectively).

## Most of the Physicians Were Satisfied with the System

One might expect that eliminating the paper-based medical record and replacing it with an EMR would cause dissatisfaction among the physicians who have been using the former throughout their careers. However, most physicians in the survey were satisfied with the use of the EMR system, both when considering the system as a whole and when considering detailed aspects of the system. When answering the five questions regarding the system as a whole, the majority gave positive responses in all of them (Fig. 7). However, in three questions, the physicians in Aust-Agder Hospital scored significantly lower than in the reference group (questions 1 through 3 in Fig. 7, Mann-Whitney U; $p = 0.045$, 0.002, and 0.004, respectively).

When considering detailed aspects of the system, the physicians were satisfied with the part of the system handling regular electronic data (Fig. 9A-C), rating it equally to that of the reference group. In the interviews, this was supported by

the internists, who were commonly emphasizing the accessibility of EMR over paper-based medical records.

### Some of the Physicians Were Not Satisfied

Although the majority of the physicians were relatively satisfied with the system, a significant proportion were not satisfied. For instance, 22.1% (15 of 68) found that the quality of the work in the department had become lower after the introduction of the EMR system (Fig. 7, question 1). Further, 19.4% (13 of 67) found that the ease with which the department's work was undertaken was decreased (Fig. 7, question 2). Regarding the detailed aspects of the system, the internists were significantly less satisfied with the part of the system handling regular electronic data than physicians in other specialties (Fig. 9, part B, analysis of variance; $p = 0.04$). Some explanation to this was found in the interviews, in which many internists considered the time required to navigate in the EMR as a significant problem. This was believed to have a negative impact on the time available for direct interaction with the patient and could subsequently lead to failure in locating necessary information due to lack of time.

### The Scanned Documents' Images

The physicians were considerably less satisfied with the use of the scanned documents' images than with the rest of the system (Fig. 9, part A, paired t-test $p$; $<0.001$ in every factor). Perhaps as a consequence, this part of the system was much less frequently used than the part that contained regular electronic data (Fig. 8, left), particularly concerning the scanned *multiple* documents (Kruskal-Wallis; $p < 0.001$ in every task). The internists were even less satisfied with them than that of the surgeons and the physicians from other wards (Fig. 9, part B, ANOVA; $p = 0.003$). During the interviews, the internists explained that navigating in the scanned multiple documents was particularly time-consuming.

## Discussion

In this study we have shown that the introduction of an EMR that contains the paper-based medical record as document images is possible without a major negative impact on reported clinical practice. As could be expected from an EMR system that precludes the users from the paper-based medical record,[13] the frequency of use of the EMR is high. Despite this fact, a majority of the physicians at most departments reported that several clinical tasks were performed more easily, and their user satisfaction scores were, on average, relatively high.

When considering the physician's frequency of use of the EMR for information retrieval, the difference between Aust-Agder Hospital and that of the reference group is distinct (Fig. 5). It may simply be accounted for in terms of lack of suitable alternatives to the EMR, although several informal sources of patient data are available to the physician (e.g., gathering printed excerpts from the EMR, asking the patient, or calling the patient's family practitioner). However, as pointed out previously,[6] EMRs are much more useful when they are complete, leading to a higher frequency of use. This is in agreement with Bleich et al.,[14] who found that a critical mass of patient data is necessary to make the physicians use the system. Also, a higher proportion of the physicians in Aust-Agder Hospital than in the reference group reported that they enter daily notes into the system (task 5, lower part of Fig. 5). This suggests that the critical mass effect might also apply to documentation, a task described as difficult to computerize in other studies.[15] Apart from entering daily notes, the physicians infrequently used the system for generating and storing information (Fig. 5, lower part). This could be due to the limited structuring and reuse of patient data in the system, forcing the user to repeatedly enter the same information. Furthermore, selecting, filling, and printing out short forms may involve more work when using the computer compared with filling it out by hand (e.g., short prescriptions, see task 12 in Fig. 6).

Regarding the performance of the clinical tasks, all tasks for which the EMR really was used were generally performed more easily (Fig. 6). This could be due to an increased accessibility of clinical information, a finding supported by results from the interviews. On the other hand, some physicians—particularly the internists—found information retrieval more difficult to perform, indicating the opposite. A possible explanation is that although the medical record is accessible to the physicians, locating specific information in a large collection of patient data can be difficult. Furthermore, any network problems and problems regarding practical access to a computer terminal will have a negative impact on this matter.

Regarding user satisfaction, the physicians were equally satisfied with the EMR containing regular electronic data as that of the physicians in the reference group (Fig. 9C). However, they were less satisfied regarding the EMR system as a whole (Fig. 7). This indicates that the changes come at a cost, and the role of the scanned document images should be considered.

The scanned document images play an essential role in making the EMR complete. However, the physicians were not satisfied with using this part of the system (Fig. 9A) and tended to avoid using it (Fig. 8). This could be due to poor practical availability of the information, as the images of multiple documents in continuous sections can be more than 50 pages long, and they are searchable only through manual scrolling. The internists were particularly dissatisfied (Fig. 9B) with the use of the scanned document images, presumably because their work depends more on the information contained in them. This contrasts the generally positive attitudes of the physicians, suggesting that the scanned document images are less prominent than the regular electronic data in clinical work. The negative aspects of the scanned document images may decrease with time, as the data in the old medical records become outdated and slowly lose their relevance. Possibly, a more comprehensive indexation and more efficient search functionality for the scanned multiple documents could improve the situation.

Four limitations of this study should be considered. First, the findings from evaluations of an EMR system in one hospital may not be valid for another hospital due to confounding factors such as financial and organizational differences[3] as well as the variation in implemented functionality in each hospital.[6] The numerous organizational changes induced by the introduction of a complete EMR system may, however, make a conventional pre–post study equally difficult to interpret. We have in this study tried to reduce the effects

of confounding factors specific to each hospital by using a reference group consisting of physicians from several hospitals. Second, the one-year difference in time between this study in Aust-Agder Hospital and the study from which the reference group of hospitals is extracted might widen the differences found between the groups. However, the EMR systems in the reference hospitals have been unchanged during this time, except from minor maintenance updates. Third, we have compared the results from one whole hospital with those of selected units from several others, which means comparing samples drawn differently. However, the proportions of physicians from units in medical, surgical, and other wards were not statistically different in the two samples ($\chi^2$ $p = 0.5$). Fourth, this study has focused on clinical processes and has not been designed to cover patient outcomes. Although desirable, we have not considered it realistic to look for quantifiable changes in patient outcome until the effects of EMR on clinical practice in this hospital is documented.[16]

## Conclusion

Scanning and elimination of the paper-based medical record are feasible, as use of an EMR that includes access to the old medical record as document images is considered acceptable by a majority of the physicians at most clinical departments. However, a significant proportion of the internists reported a negative impact on clinical work, due to the rigid structure, slow processing, and limited functionality of the scanned document images. The images should, therefore, be considered an intermediate stage toward fully electronic medical records. All considered, we believe that such a scanning project can be justified by the increased availability of patient data to the physicians and the faster transition to full utilization of an EMR. The reported disadvantages of the scanned documents may diminish over time as their contents become outdated. To our knowledge, this is the first assessment from a hospital in the process of completing such a scanning project.

*References* ■


1. Dick RS, Steen EB. The Computer-based Patient Record—An Essential Technology for Health Care, Revised Edition. Washington, DC: Institute of Medicine, National Academy Press, 1997.
2. Powsner SM, Wyatt JC, Wright P. Opportunities for and challenges of computerisation. Lancet. 1998;352:1617–22.
3. Heathfield HA, Pitty D, Hanka R. Evaluating information technology in health care: barriers and challenges. BMJ. 1998;316:1959–61.
4. Berg M. Implementing information systems in health care organizations: myths and challenges. Int J Med Inf. 2001; 64:143–56.
5. Benson T. Why general practitioners use computers and hospital doctors do not—Part 2: scalability. BMJ. 2002;325:1090–3.
6. Lærum H, Ellingsen G, Faxvaag A. Doctors' use of electronic medical records systems in hospitals: cross sectional survey. BMJ. 2001;323:1344–8.
7. Sicotte C, Denis JL, Lehoux P. The computer based patient record: a strategic issue in process innovation. J Med Syst. 1998;22:431–43.
8. Massaro TA. Introducing physician order entry at a major academic medical center: I. Impact on organizational culture and behavior. Acad Med. 1993;68:20–5.
9. Massengill SP. Image-based document management systems for medical records. Top Health Rec Manage. 1992;12(3):40–8.
10. Davis MW. Reaping the benefits of electronic medical record systems. Healthc Financ Manage. 1993;47(6):60–2, 64, 66.
11. Doll WJ, Torkzadeh G. The measurement of end-user computing satisfaction—theoretical and methodological issues. MIS Q. 1991;15(1):5–10.
12. Aydin CE, Rice RE. Social worlds, individual-differences, and implementation—predicting attitudes toward a medical information-system. Inf Manage. 1991;20(2):119–36.
13. Benson T. Why British GPs use computers and hospital doctors do not. Proc AMIA Symp. 2001:42–6.
14. Bleich HL, Beckley RF, Horowitz GL, et al. Clinical computing in a teaching hospital. N Engl J Med. 1985;312:756–64.
15. Doolan DF, Bates DW, James BC. The use of computers for clinical care: a case series of advanced U.S. sites. J Am Med Inform Assoc. 2003;10:94–107.
16. Friedman CP, Wyatt JC. Challenges of Evaluation in Medical Informatics. Evaluation Methods in Medical Informatics. New York: Springer, 1997, pp 1–12.

BMC Medical Informatics and Decision Making

BioMed Central

Research article

Open Access

# Use of and attitudes to a hospital information system by medical secretaries, nurses and physicians deprived of the paper-based medical record: a case report

Hallvard Lærum*[1], Tom H Karlsen[2] and Arild Faxvaag[1]

Address: [1]INM, Faculty of Medicine, NTNU, Trondheim, Norway and [2]Sørlandet Sykehus HF Arendal, Arendal, Norway

Email: Hallvard Lærum* - hallvard.laerum@rikshospitalet.no; Tom H Karlsen - tom.karlsen@rikshospitalet.no; Arild Faxvaag - arild.faxvaag@medisin.ntnu.no

* Corresponding author

Published: 16 October 2004

*BMC Medical Informatics and Decision Making* 2004, **4**:18 doi:10.1186/1472-6947-4-18

Received: 12 September 2003
Accepted: 16 October 2004

This article is available from: http://www.biomedcentral.com/1472-6947/4/18



## Abstract

**Background:** Most hospitals keep and update their paper-based medical records after introducing an electronic medical record or a hospital information system (HIS). This case report describes a HIS in a hospital where the paper-based medical records are scanned and eliminated. To evaluate the HIS comprehensively, the perspectives of medical secretaries and nurses are described as well as that of physicians.

**Methods:** We have used questionnaires and interviews to assess and compare frequency of use of the HIS for essential tasks, task performance and user satisfaction among medical secretaries, nurses and physicians.

**Results:** The medical secretaries use the HIS much more than the nurses and the physicians, and they consider that the electronic HIS greatly has simplified their work. The work of nurses and physicians has also become simplified, but they find less satisfaction with the system, particularly with the use of scanned document images.

**Conclusions:** Although the basis for reference is limited, the results support the assertion that replacing the paper-based medical record primarily benefits the medical secretaries, and to a lesser degree the nurses and the physicians. The varying results in the different employee groups emphasize the need for a multidisciplinary approach when evaluating a HIS.

## Background

Hospital information systems (HIS) and Electronic Medical Records (EMRs) are considered prerequisites for the efficient delivery of high quality health care in hospitals. However, a large number of legal and practical constraints influence on the design and introduction of such systems [1]. Hence, many EMR implementation projects do not aim at introducing the EMR and eliminating the paper-based counterpart in one step [2]. As a start, the EMR is introduced along with its paper-based counterpart, and both are kept updated. In such environments, health care workers have to deal with a hybrid electronic and paper-based solution. This probably limits the use of EMR [2]. Furthermore, errors are prone to develop due to cumbersome maintenance of the medical record information in dual storage media [3]. In Norway and in other countries, most hospital EMR projects have not passed beyond this phase [1]

Aust-Agder Hospital is the first hospital in Norway to eliminate the paper-based medical record, using a widespread [2] and commercially available HIS in combination with scanning technology. In a recent report, we have evaluated the EMR part of the HIS in this hospital [4], discussing the views of the physicians only. However, to get a more complete picture of the impact of the system, its use by employees other than physicians needs to be evaluated. Both medical secretaries and nurses are important users of a HIS, utilizing both the EMR and the administrative part of the system. The medical secretaries work as transcriptionists, receptionists and coordinators of patient logistics and communication, and the nurses have their own documentation and administrative routines. The elimination of the paper-based medical records is a radical change in the work routines in the hospital organization. To assess the impact of this change on the organization, the EMR system may be described from the perspectives of three important employee groups separately. In this report, we have used questionnaires and interviews to assess how often medical secretaries, nurses and physicians use the HIS system for essential tasks, how easily these tasks are performed using the system, and how satisfied the hospital employees are with it.

## Methods

### *The hospital*

The investigation was performed in a 410-bed community hospital in Aust-Agder county, Norway. The hospital serves a population of 102,000, caring for 18,600 inpatients and 74,000 outpatients per year (1998). The patients are admitted by primary care physicians external to the hospital and followed up by the hospital physicians. The hospital comprises of departments for psychiatry, general surgery, internal medicine, orthopaedics, gynecology, ear, nose and throat and ophthalmology. Well funded, and with a strong commitment by the hospital administration, the hospital staff began implementation of DIPS 2000® http://www.dips.com, a commercially available combined EMR and hospital administrative system in March 2000. In April 2001, all except the psychiatric department started to scan documents. From this date, all new patient data was channeled into the EMR in these departments, either as electronic text and data or as scanned documents. The HIS was available in 1100 terminals throughout the hospital, except for the inpatients' rooms. The transition to HIS was administered by a project group, which had been recruited from the hospital staff. The group worked in conjunction with the IT department and the HIS vendor, and was also responsible for communicating with and training the users. The group regularly held series of mandatory hands-on training classes adapted to each profession (3–8 h in total). However, a substantial proportion of the users never attended the classes, particularly the physicians. To reach these users, a task force of medical secretaries was trained and employed during the first month after implementation of the HIS for ambulant training in the wards. Further support was provided by a network of super users (the most experienced users) among the ward staff.

### *The EMR*

The patient data in the EMR part of the HIS is either stored as searchable text and numbers or as document images. The former, called "regular electronic data", essentially consists of the chronological, text-based medical record integrated with lab data in numerical form and textual radiology reports (fig 1). The latter is divided by structure into two categories, as follows: Upon admittance or consultation, the documents in the old paper-based medical records are scanned into the system as digital images in TIFF format. Each image contains all the sheets of one main section of the paper-based record, and hence corresponds to a whole document group (groups A-J in fig 1). These images are called "scanned multiple documents". Upon patient discharge, various paper sheets accumulated during the stay (e.g. the medical treatment form, printouts from diagnostic devices) are scanned, dated and labeled by document type singularly (fig 1). The resulting images are called "scanned single documents". In summary, the patient data is stored as regular electronic data, scanned multiple documents and scanned single documents. They all appear in the hierarchical list in the "medical record explorer" window (fig 2), but are treated separately in this paper, due to their difference in structure, indexation and functionality. The user interface of the HIS system is identical to all types of users, although medical secretaries, nurses and physicians often utilize different parts of system.

### *The survey*

A questionnaire previously used in a national survey of hospital physicians [2] was modified for this study. The original questionnaire contained sections regarding frequency of use of an EMR system or HIS for specified tasks, user satisfaction with the system as a whole [5] as well as detailed aspects of it [6], and availability of computers. To make the questionnaire applicable to medical secretaries and nurses, new versions of the section regarding frequency of use of the HIS were developed. In collaboration with the authors, 3–6 representatives from the medical secretaries and the nurses identified work tasks for the questionnaire each in two 2-hour group sessions, using recently developed detailed work-flow charts as templates (not shown). The identified tasks were then reduced to 23 and 19 tasks supported by the HIS, respectively (see appendix A). The questionnaire was reviewed in similar sessions by representatives from the physicians. As a result, one new task was added to the physicians' questionnaire, and four tasks not supported by the HIS were

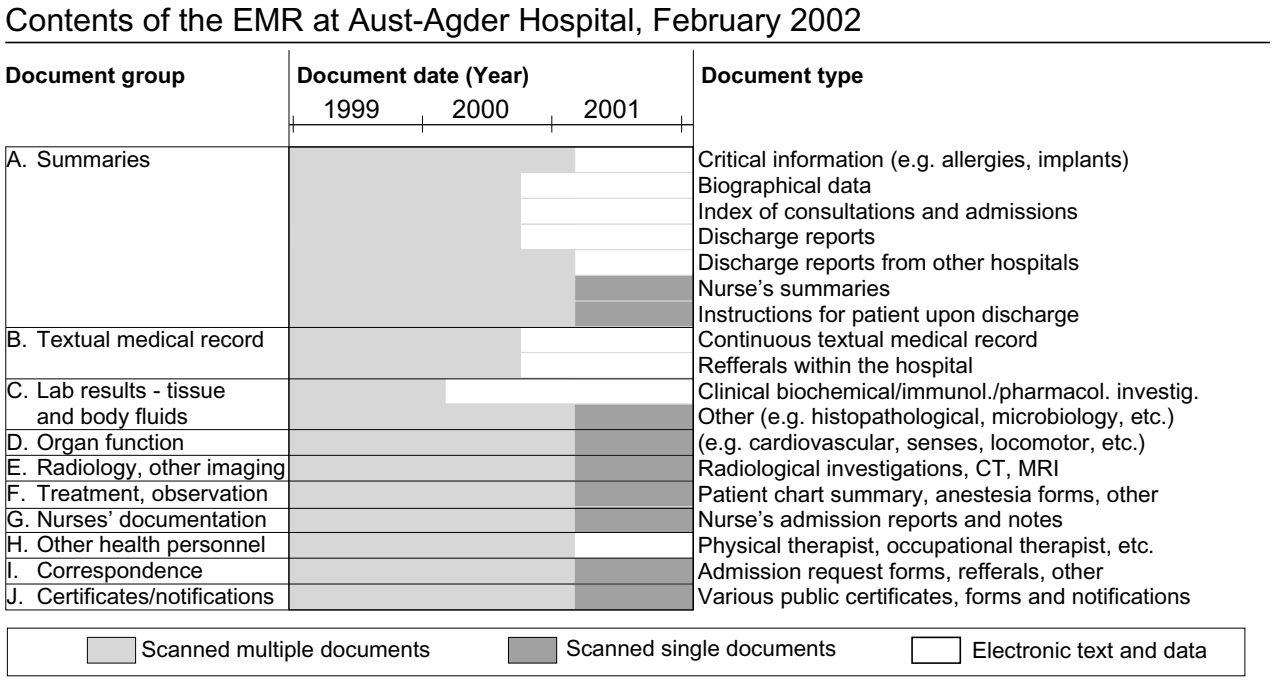



**Figure 1**
**Contents of the EMR.** Document and information types found in the EMR part of the HIS. Most documents created prior to the implementation of the HIS appear as scanned multiple documents, but some old data has been imported from existing systems and hence appears as electronic text and data. Adapted from Laerum et al [4].

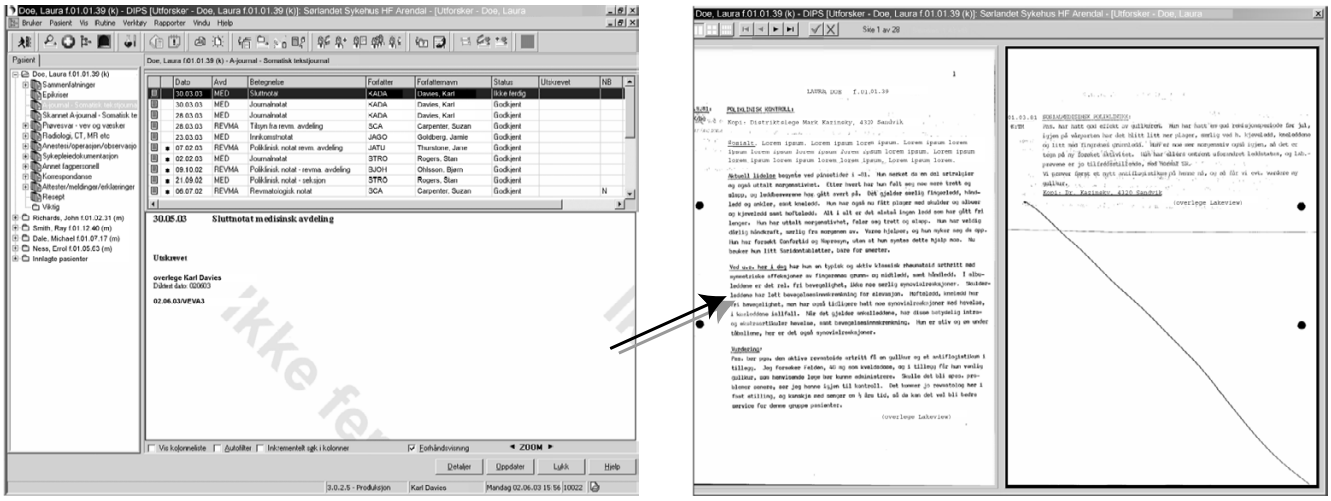



**Figure 2**
**Navigation of the EMR.** The medical record explorer and the multi-page viewer. Adapted from Laerum et al [4] and reproduced with permission from DIPS ASA, Norway.

removed. For all professions, a new section was added, containing questions about ease of performing each task using the system.

The survey was conducted during February–April 2002, and 85 medical secretaries, 235 nurses and 80 physicians in the medical, surgical and other somatic wards received the questionnaire. Of these, 79 medical secretaries (93%), 172 nurses (73%) and 70 physicians (88%) responded, giving a total response rate of 81% (321/400). We used Teleform™ for data acquisition and SPSS 11.0 for Windows™ for statistical analysis.

In addition to the survey, one of the authors interviewed 8–12 representatives of each profession for 0.5–2 hours. Comments on advantages and disadvantages of the system in all relevant work tasks were noted and summarized

## Results

The medical secretaries used the HIS routinely for most of their tasks defined in the questionnaire. This stands in contrast to the nurses and the physicians (fig 3). The number of tasks with a median response of "always or almost always" was highest for the medical secretaries (15 out of 23 tasks, 65%), and lowest for the nurses (4 out of 19 tasks, 21%).

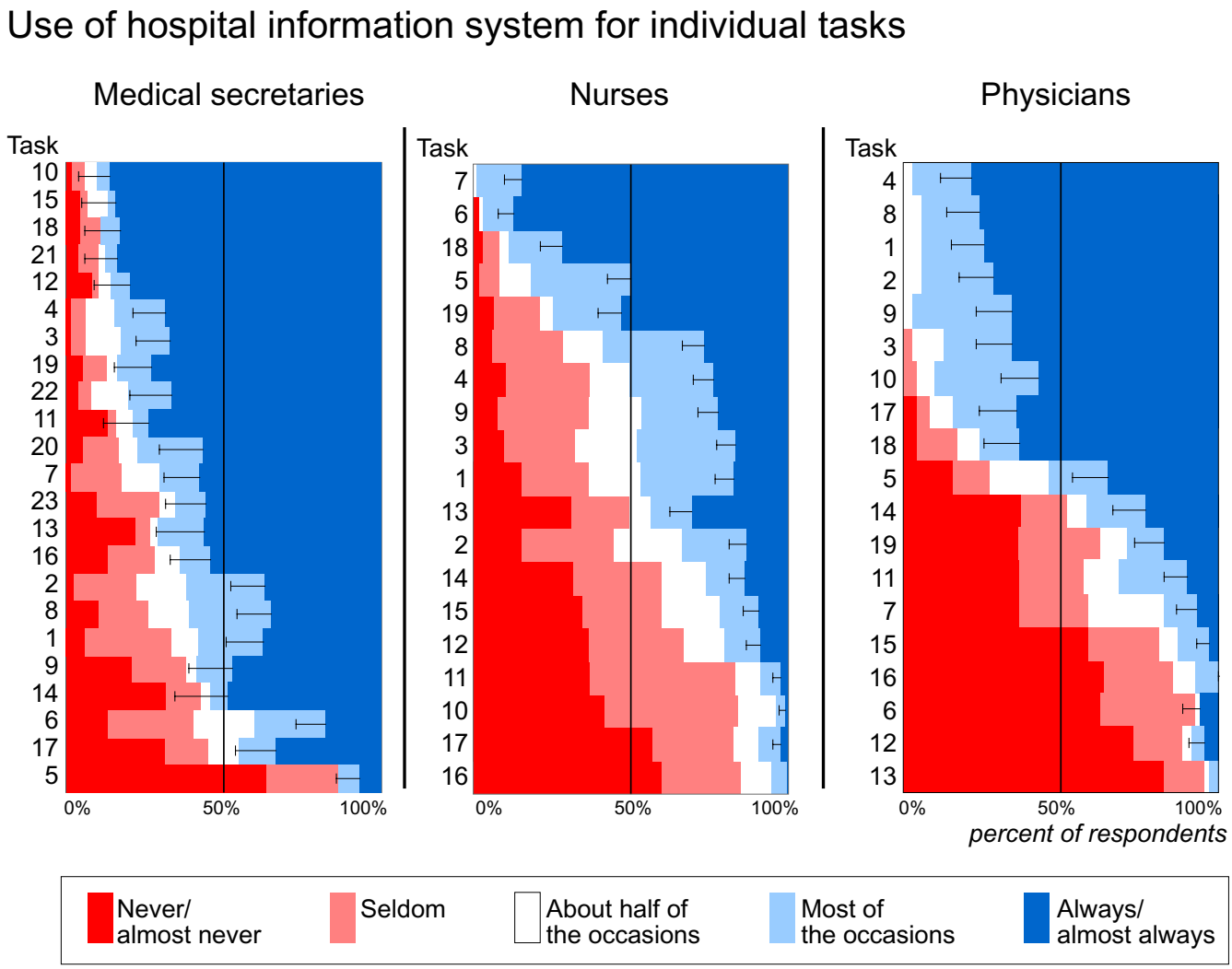



**Figure 3**

**Use of the Hospital Information System.** Frequency of use of HIS for tasks specific to each profession. Within each profession, the tasks are sorted in descending order by frequency of use. High and low frequency of use is represented by blue and red color tones, respectively. The definitions of the tasks for each profession are given in appendix A. The error bars show the confidence interval of the proportion of respondents answering "Always or almost always".

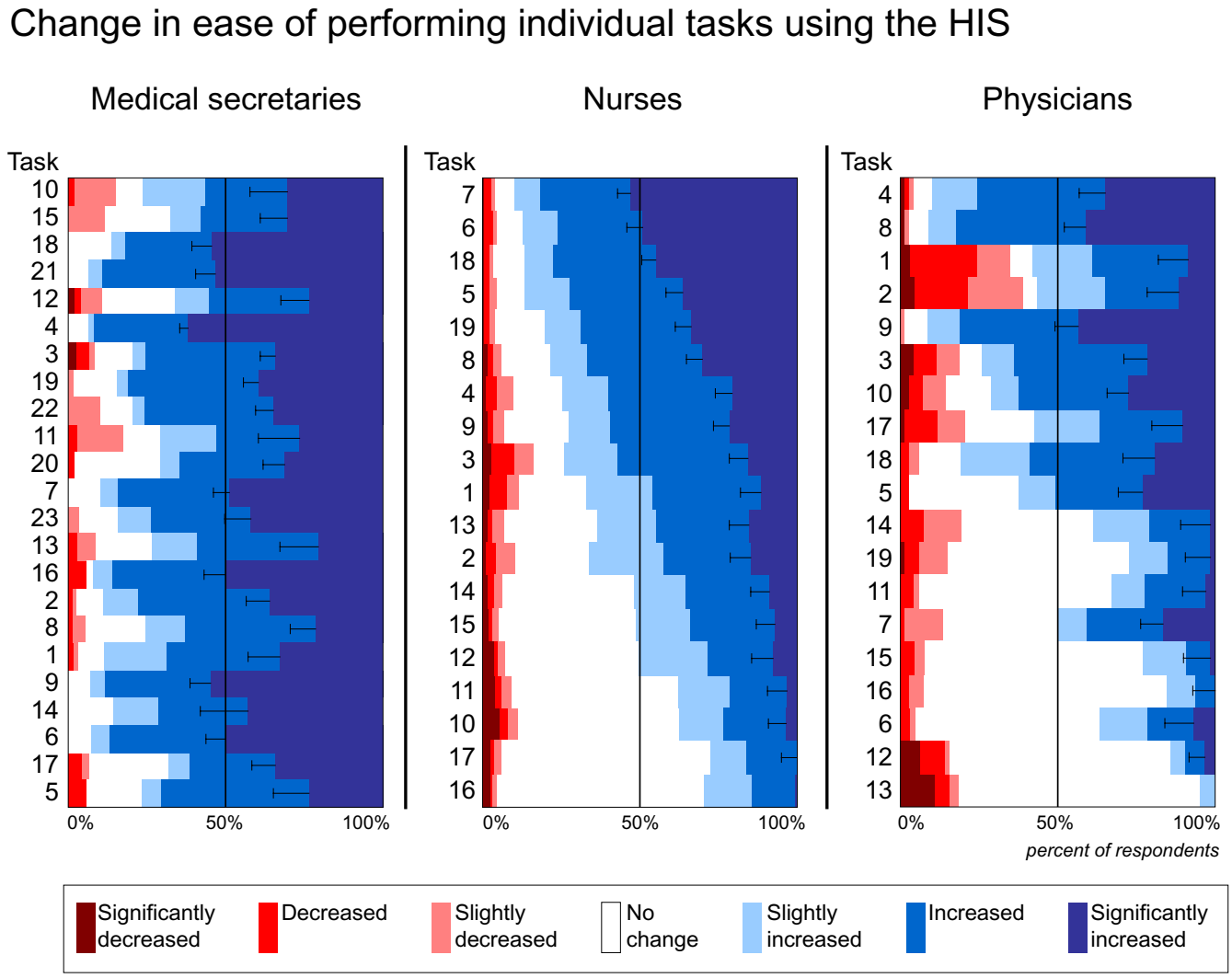



**Figure 4**
**Task performance using the HIS.** Change in ease of performing individual tasks for each profession when using the HIS. The tasks appear in the same sequence as that of figure 3, i.e. the frequency with which the HIS is used for the task. The responses indicating a task to be easier to perform appear in blue tones, and those indicating it to be more difficult appear in red. The error bars show the confidence interval of the proportion of respondents answering "Significantly increased". For definitions of the individual tasks, see appendix A. (The data for the physicians[4] is included for comparison)

The medical secretaries reported that all of the defined tasks were performed more easily than before the HIS was introduced (i.e. median response for ease of performing the task was "increased" or "significantly increased", in 23 out of 23 tasks, fig 4). In comparison, the number of tasks more easily performed was much lower for the nurses and the physicians (respectively 9 [47%] and 7 [37%] out of 19 individual tasks).

The medical secretaries were much more satisfied with the use of the HIS than the nurses and physicians, both when assessing the detailed aspects of it and the system as a whole. The detailed aspects of the HIS was assessed in twelve questions related to the factors content, accuracy, format, user friendliness and timeliness [6]. The parts of the HIS that contained scanned document images and regular electronic data were assessed separately. The medical secretaries were equally satisfied with both parts of the HIS (fig 5). This stands in contrast to nurses and in particular the physicians, who were less satisfied, particularly with the part containing the scanned document images. The difference between the professions was significant in

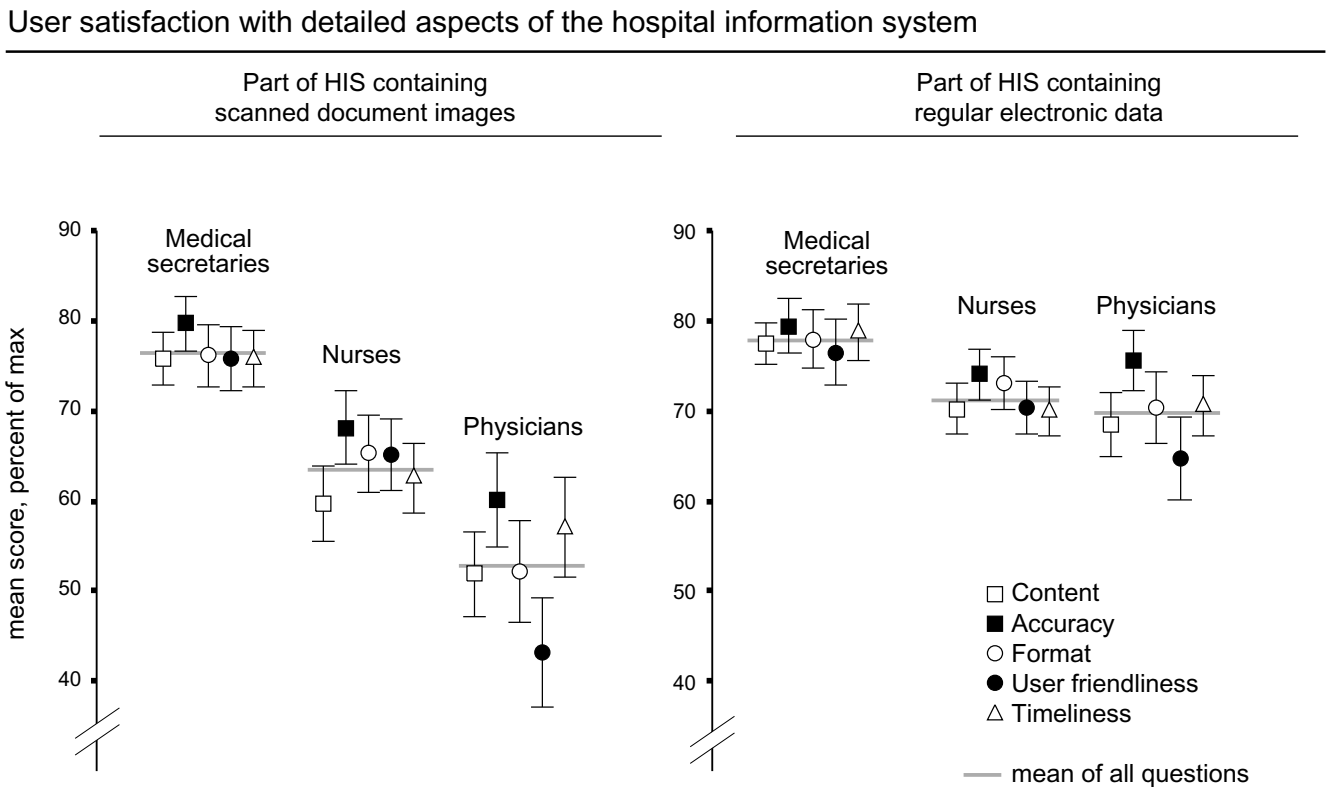


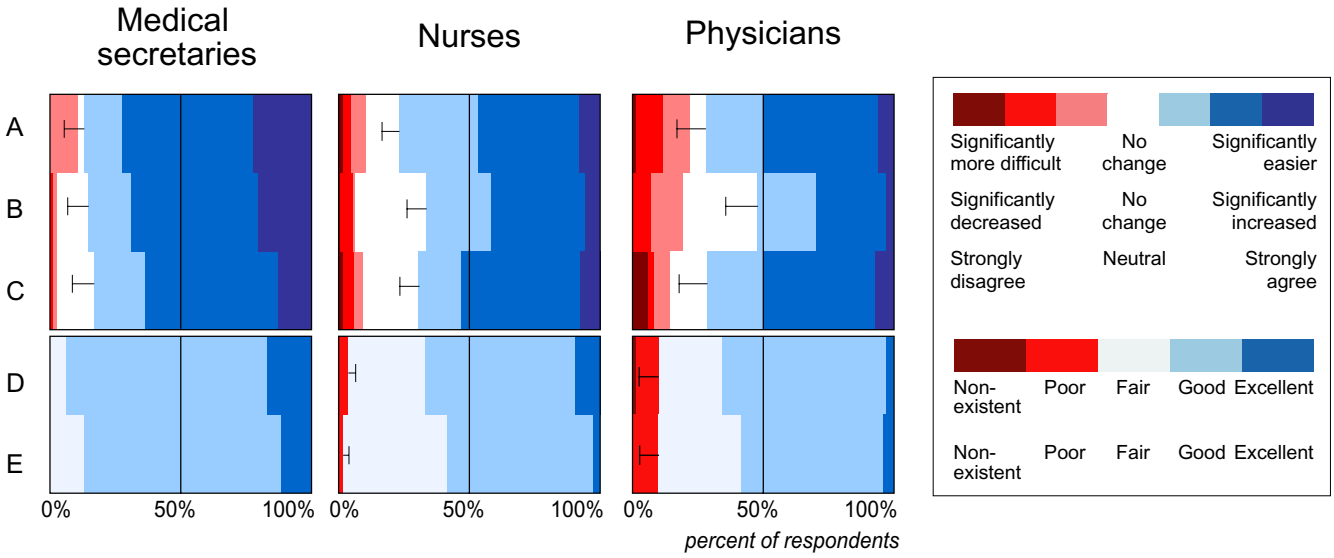

**Figure 5**
**Detailed user satisfaction.** User satisfaction with detailed aspects of the HIS in various professions. The mean scores of each factor (content, accuracy, format, user friendliness and timeliness) are shown in percent of maximum obtainable score. The error bars show the confidence interval of the mean. (The data for the physicians[4] is included for comparison)

all factors regarding the scanned document images (ANOVA $p < 0.001$), and in all factors except accuracy regarding the regular electronic data (fig 5, (ANOVA $p = 0.001$ to 0.04, $p = 0.07$ for factor 'accuracy').

In addition to the detailed aspects, the user satisfaction with the HIS as a whole was assessed (fig 6). The medical secretaries gave significantly more positive responses than the nurses and the physicians in all of the five questions in this section (Kruskall-Wallis $p = 0.05$ in question 2, $p < 0.001$ in the remaining four questions). However, the majority of each profession gave positive answers in all of these questions. To summarize all results regarding user satisfaction, the system seems to be well adapted to the work of medical secretaries but leave nurses and physicians less satisfied.

Partly explaining the differences in user satisfaction, the physicians reported more frequent problems related to availability of the HIS than the medical secretaries and the nurses (fig 7, Kruskall-Wallis $p < 0.001$ in all questions). The most frequently reported problems among the physicians occurred daily or weekly, and consisted of various software and hardware-related problems, the system working too slowly, and lack of computers where the clinical work was being done. Such problems were not frequently reported among the medical secretaries, except problems with the systems working too slowly (42% daily or weekly, 32/77).

In the interviews, the perceived advantages and disadvantages of the HIS were discussed. Both nurses and physicians in the medical ward found that patient data were more accessible when stored electronically than when stored on paper, in particular regarding lab test data. However, the nurses were still using pen and paper when documenting their activities. The medical secretaries found that generation, handling, fetching and delivery of paper documents and logistics of paper-based patient records had diminished dramatically. The generation of written text had become considerably easier. On the other hand, the scanning process had become an additional




A. The performance of our department's work has become...
B. The quality of our department's work has become...
C. The system is worth the time and effort required to use it
D. How would you rate your satisfaction with the system?
E. How would you rate the success of the system?

**Figure 6**
**User satisfaction.** User satisfaction with the HIS as a whole in various professions. The responses colored in red tones represent low satisfaction; those colored in blue tones represent high satisfaction. The error bars show the confidence interval of the combined proportion of all positive responses (The data for the physicians[4] is included for comparison).

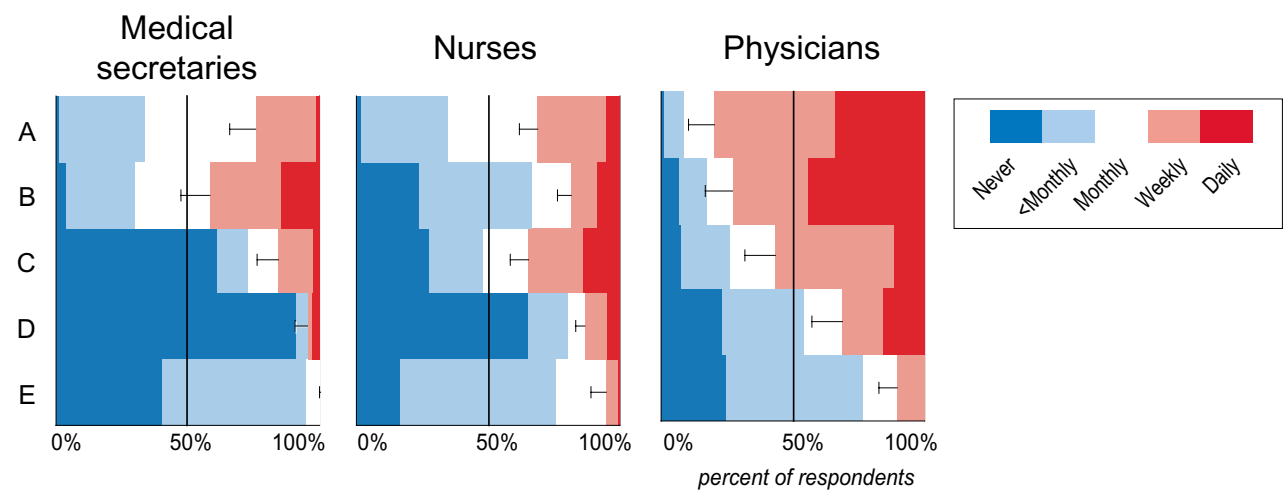
burden and was considered time consuming. Overall, handling of paper documents was considered additional work whenever the documents appeared.

## Discussion

In this hospital, we have found that the medical secretaries use the HIS more extensively for their tasks than the nurses and the physicians. Also, they are much more satisfied with the HIS.

Medical secretaries reported that they use the HIS routinely for most of the tasks defined in the questionnaire (fig 3). A simple explanation is that their tasks generally are smaller in scope and have a smaller and more easily defined range of needed information types than that of the nurses and physicians (See appendix A). Hence, the medical secretaries' tasks should be more easily supported by computers than the nurses' and the physicians' tasks. The particular inefficiencies of certain paper-based routines (e.g. regarding task 6, 15, 18 and 19) readily demonstrates the usefulness of computer support [7]. Unlike the work of nurses and physicians, the work of medical secretaries is stationary, avoiding the difficulties in providing an efficient mobile work environment. In addition, each medical secretary typically is assigned a computer, while nurses and physicians usually have to share a limited number of them (fig 7, question C). Another possible reason for the difference in usage pattern could be difference in computer literacy. However, the usage patterns were not consistent with the limited differences found in self-reported computer literacy (data not shown), and the amount of in-house training of medical secretaries and physicians was principally equal.

The medical secretaries reported that all of the tasks in their questionnaire are more easily performed (fig 4). The results from the interviews identify the elimination of the paper-based medical record as a major contributor to this,




A. How often are you prevented from or delayed in using a PC due to machine-related problems?
B. How often are you prevented from or delayed in using a PC because the system is working too slowly?
C. How often are you prevented from or delayed in using a PC because others are using them?
D. How often do you miss having a computer available where you do patient-related work?
E. How often are you prevented from or delayed in using a PC due to password problems?

**Figure 7**
**Problems related to the availability of the HIS.** Reported frequency of problems related to the availability of the HIS. The questions are sorted in descending order by the physicians' frequency of problems. Red tones represent frequent problems, and blue tones represent infrequent problems. The error bars show the confidence interval of the proportion of respondents reporting frequent problems (i.e. weekly or daily).

as several manual paper routines have disappeared (e.g. searching for a lost paper-based medial record or sorting the contents of a medical record) or are replaced by more efficient computer functions (e.g. transferring new lab data to doctors for review). Furthermore, having the administrative functions integrated with the EMR means that a substantial selection of structured demographic, clinical and administrative data is concurrently available to the users of the HIS. This makes several tasks more efficient for the medical secretaries (e.g. sending standard letters to patients in waiting lists). The results are supported by the fact that the number of medical secretaries in the hospital has been reduced by 15 since the onset of the HIS project (Bjørn Engum, personal communication Sept 2003).

Not surprisingly, the medical secretaries were more satisfied with the system than the nurses and the physicians (figs 3 and 4). This agrees with the results of Sittig [8] and Lee [9], who both found that user satisfaction was strongest correlated to questions regarding how easily the work was done. On the other hand, when comparing the user satisfaction scores to the reference data of Doll & Torkzadeh [6], the median user satisfaction score of the medical secretaries lies between the 20$^{th}$ and 30$^{th}$ percentile of the reference data set. This suggests that there is room for improvement of the EMR system regarding the medical secretaries as well as the others. Unlike the nurses and the physicians, the medical secretaries were equally satisfied with the scanned document images as that of the regular electronic medical record. The most likely reason is that the document images are not very often used by the medical secretaries, particularly the document images scanned in sections (data not shown). The disadvantages of the document images, for instance that they can not be searched, therefore seem to affect the user satisfaction of nurses and physicians to a stronger degree than that of the medical secretaries.

The use of the HIS by medical secretaries, nurses and physicians may to some degree be compared at a task-by-task level when the tasks are equally worded. In these tasks,

work roles seem to explain the differences. For instance, the tasks "Reviewing the patient's problems" (tasks 1) and "Seek out specific information from patient records" (task 2) appeared in all questionnaires. Of all the respondents, only the physicians had a significant proportion finding that these tasks were more difficult to perform than before (figure 4). A possible reason is that the physicians, in order to perform these tasks as they saw fit for their work role, more often needed to search the scanned document images extensively. When examining the task "Order clinical biochemical laboratory analyses" (task 6 for nurses, task 7 for physicians), the nurses both use the HIS more frequently for this task and find the task more easily to perform than the physicians. However, many Norwegian physicians find that order entry is a task better performed by others [10], reducing the motivation for learning the new system. This way, understanding work roles in the given context appears necessary to interpret the results.

A secondary finding in this study was that the physicians reported frequent computer-related problems, much more frequent than that of medical secretaries and nurses (fig 7). This may be due to escalated demands on computing power, system stability and availability. Without the paper-based medical record, the EMR is taken into full use and the real demands of supporting the physicians' information processing are revealed. The high reported frequency of computer-related problems may partly explain the overall lower user satisfaction of the physicians, as well as the relatively high proportion of physicians finding certain tasks more difficult to perform (task 1 and 2, fig 4). An observational study could elaborate on these relationships, focusing on what kinds of computer problems are the least tolerable to the physicians.

### *Limitations of the study*

In the questionnaire, we do not know how often each task is carried out (using the HIS or not) or how long it takes, which means that demanding tasks might be outnumbered by the less demanding ones. Furthermore, the list of tasks supported in some way by the system may not be complete, and the list does not cover the full range of conceivable tasks suited for support by any given HIS. However, given that the tasks defined for each group cover important parts of their information-related work, a cautious comparison of general patterns of use between groups of hospital employees is possible.

## Conclusion

Evaluation of a HIS in a hospital that has eliminated the paper-based medical record reveals considerable differences in user satisfaction and reported use of the system among medical secretaries, nurses and physicians. Although the basis for reference is limited, the results seem to support the claim that replacing the paper-based medical record primarily benefits the medical secretaries, and to a lesser degree the nurses and the physicians. Inspired by Aust-Agder Hospital, two of 22 other Norwegian hospitals using the same system (as of Aug 2002) are about to eliminate the paper-based medical record, making a future comparison between hospitals possible. When assessing the effects of a HIS on a hospital organization by asking users, the multidisciplinary nature of health care provision should be reflected in the selection of hospital employees that participate in the evaluation.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

HL, THK and AF planned the investigation. HL and THK developed the questionnaires for the medical secretaries and nurses. THK organized the administration of the questionnaires, and HL scanned and analysed the data. HL, THK and AF wrote the manuscript jointly.

## Additional material

### Additional File 1

Appendix A: Task lists *The three lists of tasks as they appear in the questionnaire developed for the medical secretaries, nurses and physicians, respectively.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-18-S1.doc]

### Additional File 2

*An English translation of the questionnaire used for the physicians in the survey. It is meant for review purposes.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-18-S2.pdf]

## Acknowledgments

We thank Gerd Gulstad, Bjørn Engum, Tom Schulz, Anne-Brit Riiser and Astrid Norberg for their continued help and support.

This investigation is funded by the Norwegian Ministry of Health, and the Research Council of Norway through the Kvalis project at the Norwegian University of Science and Technology, Trondheim.

## References

1. Dick RS, Steen EB: *The Computer-based Patient Record - An Essential Technology for Health Care, Revised Edition* Washington D.C., Institute of Medicine, National Academy Press; 1997.
2. Lærum H, Ellingsen G, Faxvaag A: **Doctors' use of electronic medical records systems in hospitals: cross sectional survey.** *BMJ* 2001, **323:**1344-1348.
3. Mikkelsen G, Aasly J: **Concordance of information in parallel electronic and paper based patient records.** *Int J Med Inf* 2001, **63:**123-131.

4. Laerum H, Karlsen TH, Faxvaag A: **Impacts of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice.** *J Am Med Inform Assoc* 2003, **10:**588-595.
5. Aydin CE, Rice RE: **Social worlds, individual-differences, and implementation - predicting attitudes toward a medical information-system.** *Information & Management* 1991, **20:**119-136.
6. Doll WJ, Torkzadeh G: **The measurement of end-user computing satisfaction - theoretical and Methodological issues.** *MIS Quarterly* 1991, **15:**5-10.
7. Landauer Thomas K.: *The trouble with computers : usefulness, usability, and productivity / Thomas K. Landauer* Cambridge, Mass., MIT Press.; 1995.
8. Sittig DF, Kuperman GJ, Fiskio J: **Evaluating physician satisfaction regarding user interactions with an electronic medical record system.** *Proc AMIA Symp* Bethesda, Maryland USA, American Medical Informatics Association; 1999:400-404.
9. Lee F, Teich JM, Spurr CD, Bates DW: **Implementation of physician order entry: user satisfaction and self- reported usage patterns.** *J Am Med Inform Assoc* 1996, **3:**42-55.
10. H Laerum, Faxvaag A: **Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians.** *BMC Med Inform Decis Mak* 2004, **4(1):**.

## Pre-publication history

The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1472-6947/4/18/prepub

BMC Medical Informatics and Decision Making

BioMed Central

Research article

Open Access

# Task-oriented evaluation of electronic medical records systems: development and validation of a questionnaire for physicians

Hallvard Lærum* and Arild Faxvaag

Address: INM, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway

Email: Hallvard Lærum* - hallvard.lerum@rikshospitalet.no; Arild Faxvaag - arild.faxvaag@medisin.ntnu.no

* Corresponding author

Published: 09 February 2004

*BMC Medical Informatics and Decision Making* 2004, **4**:1

Received: 17 July 2003

Accepted: 09 February 2004

This article is available from: http://www.biomedcentral.com/1472-6947/4/1



## Abstract

**Background:** Evaluation is a challenging but necessary part of the development cycle of clinical information systems like the electronic medical records (EMR) system. It is believed that such evaluations should include multiple perspectives, be comparative and employ both qualitative and quantitative methods. Self-administered questionnaires are frequently used as a quantitative evaluation method in medical informatics, but very few validated questionnaires address clinical use of EMR systems.

**Methods:** We have developed a task-oriented questionnaire for evaluating EMR systems from the clinician's perspective. The key feature of the questionnaire is a list of 24 general clinical tasks. It is applicable to physicians of most specialties and covers essential parts of their information-oriented work. The task list appears in two separate sections, about EMR use and task performance using the EMR, respectively. By combining these sections, the evaluator may estimate the potential impact of the EMR system on health care delivery. The results may also be compared across time, site or vendor. This paper describes the development, performance and validation of the questionnaire. Its performance is shown in two demonstration studies (n = 219 and 80). Its content is validated in an interview study (n = 10), and its reliability is investigated in a test-retest study (n = 37) and a scaling study (n = 31).

**Results:** In the interviews, the physicians found the general clinical tasks in the questionnaire relevant and comprehensible. The tasks were interpreted concordant to their definitions. However, the physicians found questions about tasks not explicitly or only partially supported by the EMR systems difficult to answer. The two demonstration studies provided unambiguous results and low percentages of missing responses. In addition, criterion validity was demonstrated for a majority of task-oriented questions. Their test-retest reliability was generally high, and the non-standard scale was found symmetric and ordinal.

**Conclusion:** This questionnaire is relevant for clinical work and EMR systems, provides reliable and interpretable results, and may be used as part of any evaluation effort involving the clinician's perspective of an EMR system.

## Background

Evaluation is a challenging but necessary part of the development cycle of clinical information systems like the electronic medical records (EMR) systems in hospitals. EMR systems handle the storage, distribution and processing of information needed for health care delivery of each patient. Such systems have been described as "complex systems used in complex organizations", and their evaluation seems to follow that logic. It is generally believed that multiple perspectives need to be considered, and that qualitative and quantitative methods should be integrated when evaluating EMR systems [1]. In addition, the evaluation should include a comparative element [2] and rely heavily on how humans react to the system [3]. Since the multi-perspective, multi-methodical approach easily exceeds any perceivable amount of allocated resources, methods that require modest resources should be considered whenever possible. Task-oriented self-reporting of EMR use and task performance is one such quantitative method.

In this paper, we present a new questionnaire instrument. The questionnaire may be used to survey and compare the physicians' use of and performance with a given EMR system at various points of time. Furthermore, it may be used to compare general patterns in use and performance to that of EMR systems in other hospitals and from other vendors. EMR use is not necessarily a quality indicator by itself, but an indicator of potential impact of the system. Specific problem areas may be identified by demonstrating a self-reported lack of EMR use or a reduced reported performance of specific tasks. Although clinically oriented task inventories have been published previously, these tasks inventories have been found either too broad [4,5], or too detailed [6] for the questionnaire's intended purpose. Also, very few of them have been tested in several sites or with various EMR systems. Bürkle et al [7] states that questionnaires should be specified depending on the functions of the observed computer system. The design of the questionnaire makes this specification possible, as the tasks generally follow the boundaries of common EMR functionality. In addition, a table of minimum functionality requirements for each task is publicly available [8]. In this paper, we describe the development and successful application of the questionnaire in two demonstration surveys. Support for the validity of its content is demonstrated in an interview study, and that of the questions' reliability by a test-retest study [9]. In addition, a modified response choice scale is investigated in a scaling study.

## Methods

### *Development of the task list for the questionnaire*

The questionnaire is task-oriented, i.e. it builds upon 24 general tasks essential to physicians' work. These tasks have been formulated by a work group comprised of two computer scientists and two physicians, including the author. The group based their work on observations of 40 hours of clinical activity in five departments in two university teaching hospitals, performed January-February 2000 by two of the members of the group. Parts of the observations (7 hours observation time, five physicians from two departments, 27 patients) were transcribed verbatim and categorized by hierarchical task analysis [10]. However, the resulting hierarchy of low-level tasks was too large (104 tasks) for use in questionnaires. Thus, the tasks were transformed and merged into higher-level tasks. In the process, they were aimed at being easy to understand, relevant for clinical work in all specialties and attributable to the functionality found in present EMR systems. Tasks regarded as rarely performed, representing negligible time consumption or not likely to be supported by an EMR system in the near future were deleted. Further, the principal information needs of physicians defined by Gorman [11] were taken into account by adding three new tasks (table 1, tasks 6, 7 and 8). We used the refined list of 23 clinical tasks in a national survey, the first demonstration study in this paper [8]. Preceding the second demonstration study, a local survey [12], the questionnaire was reviewed in Aust-Agder hospital by six internists in two focus group sessions, and one new task (table 1, task 24) was added to the list. In November 2002, we used video recordings (4.5 h) of two physicians in a rheumatology outpatient clinic attending to nine patients to review the 24 defined tasks, but the tasks were unchanged. Definitions and examples of all tasks are found in additional file 1. Although native English speaking professionals were consulted during translations, all translated material should be regarded as guiding rather than final.

### *Development of the questions and the response labels in the questionnaire*

The questionnaire principally consists of two sections; one covering self-reported frequency of use of a given EMR system, the other covering perceived ease of performing them using the system. The first section appeared in the national survey, and both sections in the local survey. The questions and response labels were adapted from validated questionnaires, Doll & Torkzadeh [13] and Aydin & Rice [14], both appearing in Anderson et al [15]. Within each section, the questions are equally worded for every task. For details on the incremental changes of each revision of the questionnaire, see appendix A in additional file 17.

### *Validation of the questionnaire*

The validation of the questionnaire was performed in four separate studies.

**Table 1: List of tasks. Tasks used in the various revisions of the questionnaire.**

| No. | Task | Rev. 1 National study | Rev. 2 Local study | Rev. 3 Test-retest study and interviews |
|---|---|---|---|---|
| 1 | Review the patient's problems | x | x | x |
| 2 | Seek out specific information from patient records | x | x | x |
| 3 | Follow results of a test or investigation over time | x | x | x |
| 4 | Obtain results from new tests or investigations | x | x | x |
| 5 | Enter daily notes | x | x | x |
| 6 | Obtain information on investigation or treatment procedures | x | | x |
| 7 | Answer questions concerning general medical knowledge (e.g. concerning treatment, symptoms, complications etc.) | x | | x |
| 8 | Produce data reviews for specific patient groups | x | x | x |
| 9 | Order clinical biochemical laboratory analyses | x | x | x |
| 10 | Obtain results from clinical biochemical laboratory analyses | x | x | x |
| 11 | Order X-ray, ultrasound or CT investigations | x | | x |
| 12 | Obtain results from x ray, ultrasound, or CT investigations | x | x | x |
| 13 | Order other supplementary investigations | x | | x |
| 14 | Obtain results from other supplemental investigations | x | x | x |
| 15 | Refer patient to other departments or specialists | x | x | x |
| 16 | Order treatment directly (e.g. medicines, operations etc.) | x | | x |
| 17 | Write prescriptions | x | x | x |
| 18 | Write sick leave notes | x | x | x |
| 19 | Collect patient data for various medical declarations | x | x | x |
| 20 | Give written specific information to patients (e.g. about medications, disease status.) | x | x | x |
| 21 | Give written general information to patients | x | x | x |
| 22 | Collect patient information for discharge reports | x | x | x |
| 23 | Check and sign typed dictations | x | x | x |
| 24 | Register codes for diagnoses or performed procedures | | x | x |

*Structured interviews with physicians*

Content validity of the questionnaire was addressed by a structured interview study of physicians from ten selected departments in a university teaching hospital. The two senior residents and eight consultants were named by the head of each department. Three physicians refused to be interviewed, and were substituted by others from the same department. Each one-hour interview was recorded digitally, initiated by the physician filling out the questionnaire whilst being observed. A fixed set of 153 open and closed questions were asked [9,16] mostly about the defined tasks in the questionnaire. During the interviews, answers to the open questions were transcribed and that of the closed questions were registered directly in a database. Unclear or incomplete transcriptions were revised and completed using the recordings of the interviews. We analyzed the open questions qualitatively by categorizing the responses into themes. The interview guide is provided in additional file 11 and 12.

*Post hoc analysis of two demonstration studies*

The data from two published demonstration studies were used for missing response analysis and criterion validation. The first, a national survey, comprised of responses from 219 of 307 physicians (72%) in 17 hospitals [8]. The survey included task-oriented EMR use and two translated user satisfaction measures; the Doll & Torkzadeh's "End User Satisfaction scale" [13] and Aydin & Rice's "Short global user satisfaction measure" [14]. The second demonstration study, a local survey, comprised of responses from 70 of 80 physicians (88%) in Aust-Agder Hospital [12]. The questionnaire contained all of the questions from the national survey, except those regarding five tasks not supported in this hospital (table 1). In addition, the section covering task performance was added in this second revision of the questionnaire (table 2). The questionnaires used in these studies are provided in Norwegian original and English translated versions in additional files 2, 3 and 5, 6.

*Test-retest study*

We measured test-retest reliability in a postal survey of physicians from three hospitals having EMR systems from separate vendors. Within each hospital, equal groups of physicians were randomly selected from surgical, medical and other wards. The first questionnaire was sent to the 96 included physicians, and a reminder was sent to 57 non-responders two weeks later. Three weeks after this, the sec-

**Table 2: Questionnaire revisions. Overall structure of the revisions of the questionnaires. Sections not covered in this paper are hidden. For the questionnaires, see additional files 3, 6 and 9.**

| Questionnaire revision | No. of questions | Section in questionnaire |
|---|---|---|
| **Rev.1 National study** | | |
| Frequency of PC use for each task, use of EMR or other program | 23 + 23 | D |
| End User Computing Satisfaction[13] | 12 | F |
| Short Global User Satisfaction[14] | 5 | G |
| **Rev. 2 Local Study** | | |
| Frequency of EMR use for each task | 19 | D1, D2 |
| Task performance using the EMR, compared to previous routines | 19 | F |
| End User Computing Satisfaction[13] | 12 | E1, E2 |
| Short Global User Satisfaction[14] | 5 | G |
| **Rev. 3, Test-Retest study and Interviews** | | |
| Frequency of EMR use for each task | 24 | B1, B2 |
| Task performance using the EMR, compared to previous routines | 24 | C |
| End User Computing Satisfaction[13] | 12 | D |
| Short Global User Satisfaction[14] | 5 | E |

ond questionnaire was sent to the 52 responders along with a music compact disc as inducement. The response rate of the first and second questionnaire was 55.2% (52/96) and 71% (37/52), respectively. On average, we received the second questionnaire 4.4 weeks after the first. To estimate test-retest reliability in the task-oriented questions, we used Cohen's weighted kappa. The kappa values were interpreted according to Lewis' guidelines [17]. The questionnaire used in this study is provided in Norwegian original and English translated version in additional files 8 and 9.

*Scaling of response labels*

To validate and scale the response labels in the "Frequency of EMR use" scale, we selected 31 respondents by convenience sampling and asked them to interpret a set of response labels by placing marks on a visual analogue scale (VAS). The VAS ranged from "never" to "always", and the eight Norwegian labels (five original response labels and three alternatives) appeared on separate sheets in random order. Using a standard ruler, we measured the marks on the VAS in millimeters from the "never" end, and calculated the mean VAS value and confidence interval for each response label, as well as the number of disordinal label pairs [18]. The combination of labels providing the lowest number of disordinal pairs was selected for the final frequency scale. The VAS form used in this study is provided in additional file 15.

### *Computer programs used*

Teleform™ 8 was used for data acquisition of postal surveys, Microsoft Access 2002™ for data management and data acquisition during interviews, OntoLog [19] 1.4 for indexing and analysis of video and audio material, StatExact™ 5.0 for calculating the kappa statistic and SPSS™ 11.0 (Windows) for all other statistical analysis.

## Results

The studies provided evaluation of the questionnaire in terms of 1) content validity, 2) compliance, 3) criterion validity, 4) test-retest reliability and 5) scaling of response labels.

### *Content validity*

*Relevance of tasks*

The interviews included structured questions about task relevancy, frequency and time consumption. The majority of the physicians (7–10 of 10) found each of the 24 tasks part of their work, except task 8 (figure 1, section A). In the open-ended questions, they perceived this task partly as an administrative task best performed by other personnel, and partly as not fully applicable to medical work (table 3, themes 1 and 5). However, four of five physicians who did not consider this task a part of their job agreed that it could be a part of it in the future, provided new technology was implemented. The comments transcribed during the interviews suggested that tasks otherwise considered appropriate for other staff could be done by physicians (e.g. gather and present data to the physicians, mediate orders to other instances), if computer support would make the tasks less time consuming (theme 1).

To broadly assess the amount of work represented by each task, the physicians were asked to estimate frequency and time consumption of each task. Regarding frequency, most physicians (7–10 of 10) found that all but four tasks

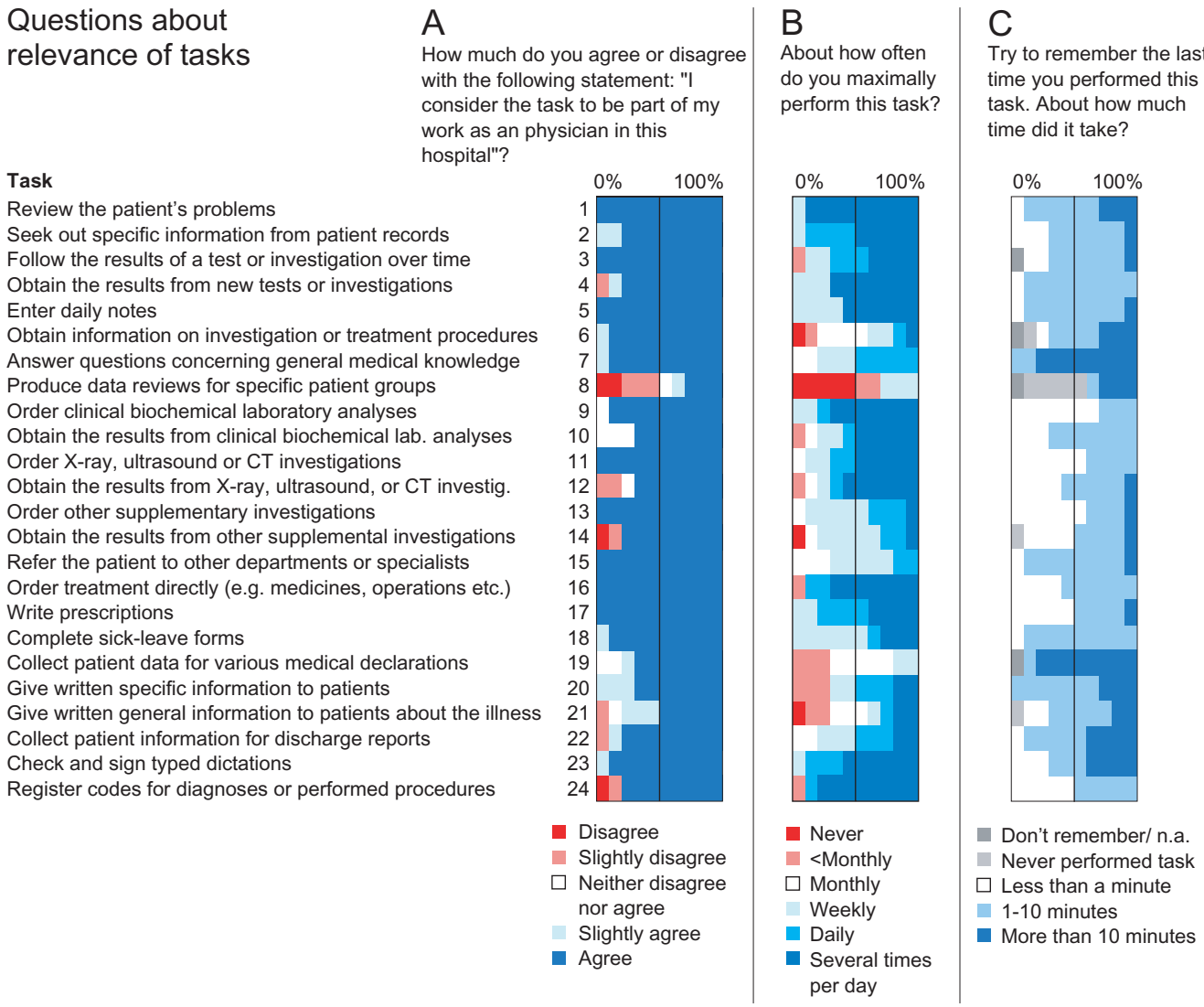



**Figure 1**
**Relevance of tasks** Responses in the interview study about A) task relevance, B) how frequently they maximally are performed, and C) how much time the physicians estimate that they take.

were performed frequently, i.e. maximally weekly or daily (median value). Tasks 8, 6 and 19 were all infrequently performed, i.e. maximally less than monthly, but they were relatively time consuming. Regarding the time consumption of each task, most of the tasks (17 of 24) were estimated to 1–10 minutes, and two tasks to more than 10 minutes (tasks 7 and 19). Some tasks (5 of 24 tasks) were estimated to take less than a minute using current paper-based routines (e.g. order lab tests, write prescriptions, register codes), but these tasks were performed frequently (figure 1, part B).

*Accuracy of task interpretation, and estimation of EMR use*

The interviews included structured questions about how the physicians interpreted each task, and whether they found answering the accompanying question about EMR use (figure 2) difficult or not. The majority of the physicians found all tasks comprehensible (figure 2, part A). As a control, we asked eight of the physicians to formulate their interpretation of each task in their own words. All respondents who chose the identical wording to that of the defined task were requested to name an example. The answers, either formulations or examples, were compared

**Table 3: Themes from the interviews. The themes, typically appearing in open-ended questions, are sorted in descending order by the number of physicians providing answers attributable to the given theme. In the "Tasks" column, the tasks to which each answer is attributed are sorted in descending order by number of physicians commenting the task. In the "Typical quote" column, the quotes are followed by the physician's specialty in parentheses.**

| Theme | | No. of physicians (no. of quotes) | The tasks mentioned in relation to this theme, by number of physicians: | | | | Typical quote |
|---|---|---|---|---|---|---|---|
| | | | 4 | 3 | 2 | 1 | |
| 1 | Work role issues | 8 (34) | 10 | 19 | 6, 9, 8, 24 | 2, 4, 5, 7, 11, 12, 13, 14, 18, 20, 21, 22 | *The third method would be the "ask-the-nurse" method. This is convenient, though, then I may do other things. [In the future] It could be that it will be so easy to do it, that I could do it myself...if it's really easy, a completely negligible task. But if it takes some time..if I have to wait or something..then I feel that it should be a medical secretary's task, at least in a hospital.* (respiratory diseases) |
| 2 | Wording problems | 7 (21) | | 16 | 4, 21 | 1, 7, 12, 13, 22 | *I don't understand what you mean with "directly"...write orders on the [order entry form], request or order an operation...one other [example] is requesting treatment by physiotherapist* (orthopedy) |
| 3 | Questions regarding use of non-existent functionality | 7 (11) | | | 3 | 6, 9, 14, 15, 18 | *Some questions are difficult to answer, as we can't log on [to the EMR system] and find results from X-ray investigations* (plastic surgery) |
| 4 | Distinguishing EMR from other software or media | 6 (8) | | | 4 | 2, 3, 6, 7 | *Is [the separate lab system] regarded as a part of [the EMR system]?* (neurology) |
| 5 | Task not fully applicable to clinical work | 6 (10) | | | 8, 20, 21 | 3 | *I've hardly ever been there. I spend a lot of my time providing information [to the patient] verbally. Written information is rarely demanded [by the patient]. I'm sceptical towards providing it in writing...because it must be individualized, and that's much harder in writing than verbally...and if I do, it will usually be copies of notes from the medical record.* (oncology) |
| 6 | Functionality missed by the respondent | 5 (7) | | | | | *..well, this is about everyday work, after all. You don't ask about what [in the EMR system] might be improved...This is all only about what's already there.* (orthopedy) |
| 7 | Distinguishing other employee's use of the system from one's own | 5 (6) | | | 5 | 15 | *Here I was wondering whether you mean the notes I write myself, or the dictation and [the text] typed by others. I'd recon that it would include dictation.* (neurology) |
| 8 | EMR only partly supports the defined task | 5 (12) | | | 1, 3, 19 | 2, 4, 22 | *Well, you use [the EMR system], too, but you may never write any of those things without having the rest of the medical record available. You sort of get "black-and-white" alternatives, without being permitted to comment anything. It's not a simple yes or no type of question. After all, you can't found your work on [the EMR system] only.* (oncology) |
| 9 | Knowing the EMR functionality | 3 (8) | | | | | *..is [writing a prescription] available here? Sick leave forms, too?* (neurology) |

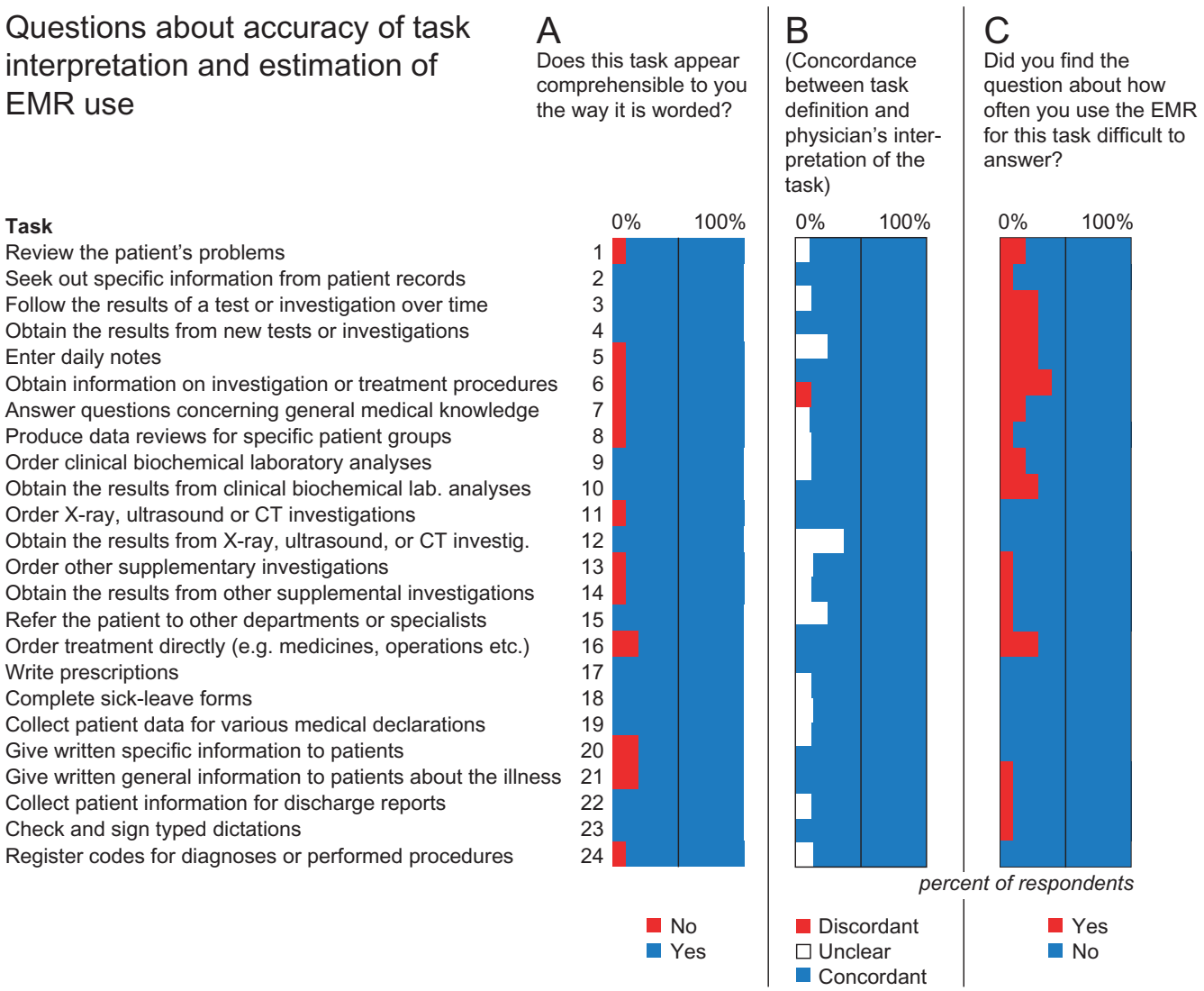



**Figure 2**

**Accuracy of task interpretation, and estimation of EMR use** Responses in the interview study about A) whether a task is comprehensible or not, B) whether the physicians' interpretation of each task fitted the actual definition or not, and C) whether estimation of own EMR use for given task was found diffcult or not.

to the original task definitions. Answers that complied to whole or essential parts of the task definitions were categorized as concordant, and those that did not comply as discordant. Unclear, incomplete or ambiguous answers were categorized as unclear. All of the tasks had a majority of concordant answers, despite some unclear answers (figure 2, part B). Only tasks 7 had a small proportion of discordant interpretations (1 of 8 respondents).

Nine of the 24 task-oriented questions about EMR use were found difficult to answer by 2–4 of 10 physicians (figure 2, part C). Five of these addressed functionality not specifically supported by the EMR. An escape choice ("Task not supported by EMR") had been provided, but the physicians never the less found answering these questions confusing. Further explanations were found in the open-ended questions (table 3).

*Themes appearing in open-ended questions*

The answers to the open-ended questions and the spontaneous comments were categorized into themes. Those mentioned by at least two physicians are shown in table

**Table 4: Missing responses in the demonstration studies. The median proportions of missing responses to task-oriented questions in the national and local demonstration study are shown in this table.**

| Demonstration study | Task-oriented questions | Median missing responses (range) |
|---|---|---|
| National study | Frequency of PC use | 1.8% (1.4% – 3.2%) |
| | Use EMR / use other program | 21.0% (5.9% – 51.1%) |
| Local study | Frequency of EMR use | 0.0% (0.0% – 1.4%) |
| | Task performance | 2.9% (1.4% – 14.3%) |

3. The quantitative and qualitative data from the interview study are provided in additional files 13 and 14, respectively.

### *Compliance*

Overall, the task-oriented questions had a low percentage of missing responses both in the national and in the local demonstration study. However, the questionnaire design in the former was slightly problematic. In the national study, each question about frequency of PC use for a given task was followed by a question about type of computer program used (i.e. "EMR" and/or "other program"). The percentage of missing responses was low in the former, but quite high in the latter (table 4). As a consequence, a number of respondents reported that they were using a computer without telling whether they were using the EMR or not. This subgroup needed to be presented along with explicitly reported EMR use, making interpretation and presentation of the results challenging. The subgroup was particularly large in tasks 10 [Obtain results from clinical biochemical laboratory analyses] and 4 [Obtain results from new tests or investigations] (27.4% and 24.7%, respectively).

In the local demonstration study, we simplified the task-oriented questions about PC use by limiting them to EMR only. In addition, we omitted questions about tasks not explicitly supported by the EMR under study. In this study, the percentages of missing responses were low, both in the questions about EMR use and in those about task performance. In the latter, the question for task 8 [Produce data reviews for specific patient groups] had the highest proportion of missing responses (14.3%). However, the reported EMR use for this task was very low in this study (91% of the physicians answered "seldom" or "never/almost never").

### *Criterion validity*

Criterion validation was assessed in three ways, by correlating task-oriented EMR use to general EMR use, task performance to overall work performance, and task performance to user satisfaction. As the first criterion, we assessed general EMR use by asking the physicians about how often they used the EMR as an information source in their daily clinical work (table 5, row 1). This question correlated to nine of the 12 tasks about information retrieval, and to 12 of all 24 tasks. This suggests that a considerable proportion of the tasks are regarded essential to EMR's function of information retrieval. Of the remaining three tasks of this kind (tasks 6–8), explicit functionality was available only for task 8 [Produce data reviews for specific patient groups] in this study. As a second criterion, we assessed overall work performance by asking whether performance of the department's work, and that of the respondent's work, had become easier or more difficult using the EMR system (table 5, row 2–4). A high proportion of the questions about task performance correlated to both forms of overall work performance, which suggests that these tasks are regarded important elements of clinical work. As a third criterion for validation of the tasks, we calculated correlations between task performance and two standard measures of user satisfaction (table 5, row 5–8). Both measures correlated to high proportions of the tasks, but the Short Global user Satisfaction measure correlated to more tasks than that of End User Computing Satisfaction measure. The EMR was seldom or never used for the tasks for which no correlation between task performance and user satisfaction was found (notwithstanding tasks 19 [Collect patient data for various medical declarations] in the local study and task 15 [Refer patients to other departments or specialists] in the test-retest study). The data from the demonstration studies are provided in additional files 4 and 7.

### *Test-retest reliability*

In the test-retest study, we measured reliability by calculating Cohen's weighted kappa (quadratic weights) for all task-oriented questions. Generally, the weighted kappa was high (figure 3), but the questions about EMR use showed better reliability than that of task performance (median kappa 0.718 and 0.617, respectively).

In the questions about EMR use, kappa values indicating excellent test-retest agreement was found in seven tasks (figure 3). On the other hand, a low or non-significant kappa was found in tasks 7, 9, 13, and in the questions

**Table 5: Criterion validity. Significant correlations (Spearmans' rho) between task-oriented and overall questions about frequency of EMR use, work performance and user satisfaction. In the test-retest study, data from its first part was used for this analysis (61 physicians from three hospitals). *Tasks related to information retrieval.**

| | *In the...* | *...the task-oriented questions about...* | *...correlates to...* | *...in number of questions:* | *Median correlation coefficient (range)* |
|---|---|---|---|---|---|
| **Criterion validation for task-oriented questions** | | | | | |
| **Frequency of EMR use: individual tasks vs. general information retrieval** | | | | | |
| 1 | test-retest study | frequency of EMR use (B1-1 to B1-24) | question B2-2: ``All considered, how often do you use the EMR as an information source in the daily clinical work? (never-always)'' | 12 of 24 (50%) and 9 of 12* (75%) | 0.516 (0.308 – 0.675) |
| **Task performance vs. overall work performance** | | | | | |
| 2 | local study | task performance (F1-F19) | question G1a ``The performance of our department's work has become... (significantly more difficult - significantly easier)'' | 17 of 19 (89%) | 0.513 (0.286 – 0.684) |
| 3 | test-retest study | task performance (C1-C24) | question E3a: ``The performance of our department's work has become... (significantly more difficult - significantly easier)'' | 20 of 24 (83%) | 0.427 (0.329 – 0,662) |
| 4 | test-retest study | task performance (C1-C24) | question E3b: ``The performance of my own tasks has become... (significantly more difficult - significantly easier)'' | 21 of 24 (88%) | 0.435 (0.291 – 0.689) |
| **Task performance vs. user satisfaction** | | | | | |
| 5 | local study | task performance (F1-F19) | the End user Computer Satisfaction measure | 13 of 19 (68%) | 0.483 (0.273 – 0.592) |
| 6 | test-retest study | task performance (C1-C24) | the End user Computer Satisfaction measure | 15 of 24 (63%) | 0.458 (0.328–0.682) |
| 7 | local study | task performance (F1-F19) | The Short Global User Satisfaction measure | 16 of 19 (84%) | 0.512 (0.332 – 0.686) |
| 8 | test-retest study | task performance (C1-C24) | The Short Global User Satisfaction measure | 20 of 24 (83%) | 0.445 (0.348 – 0.711) |

about task performance in tasks 15, 16 and 21. No tasks performed poorly in both EMR use and task performance. (The data from the test-retest study is provided in additional file 10).

### *Scaling of response labels*

In the scaling study, the original set of labels performed better than the alternatives. In the best alternative set of labels, the number of disordinal pairs was 5%, but the original combination of labels remained the better choice at 4%. The mean positions of the original labels (figure 4) constituted a symmetrical, s-shaped curve. The confidence intervals of the sample show some overlap between adjacent labels (figure 4), whereas the confidence intervals of the mean do not (data not shown, ANOVA $p < 0.001$, LSD $p < 0.001$ between all labels).

We regarded the response choices in the task performance questions as standard, and hence did not include them in this study. (The data from the scaling study is provided in additional file 16.)

## Discussion

The results suggest that this questionnaire may provide valid and reliable information about how an implemented EMR system is utilized on an overall level in clinical practice, and how well the system supports clinical tasks.

### *The tasks-oriented questions are relevant for clinical work, but some are difficult to answer*

During development, the tasks have been based on observations of clinical activity, and further refined to suit their purpose as a common denominator for assessments of

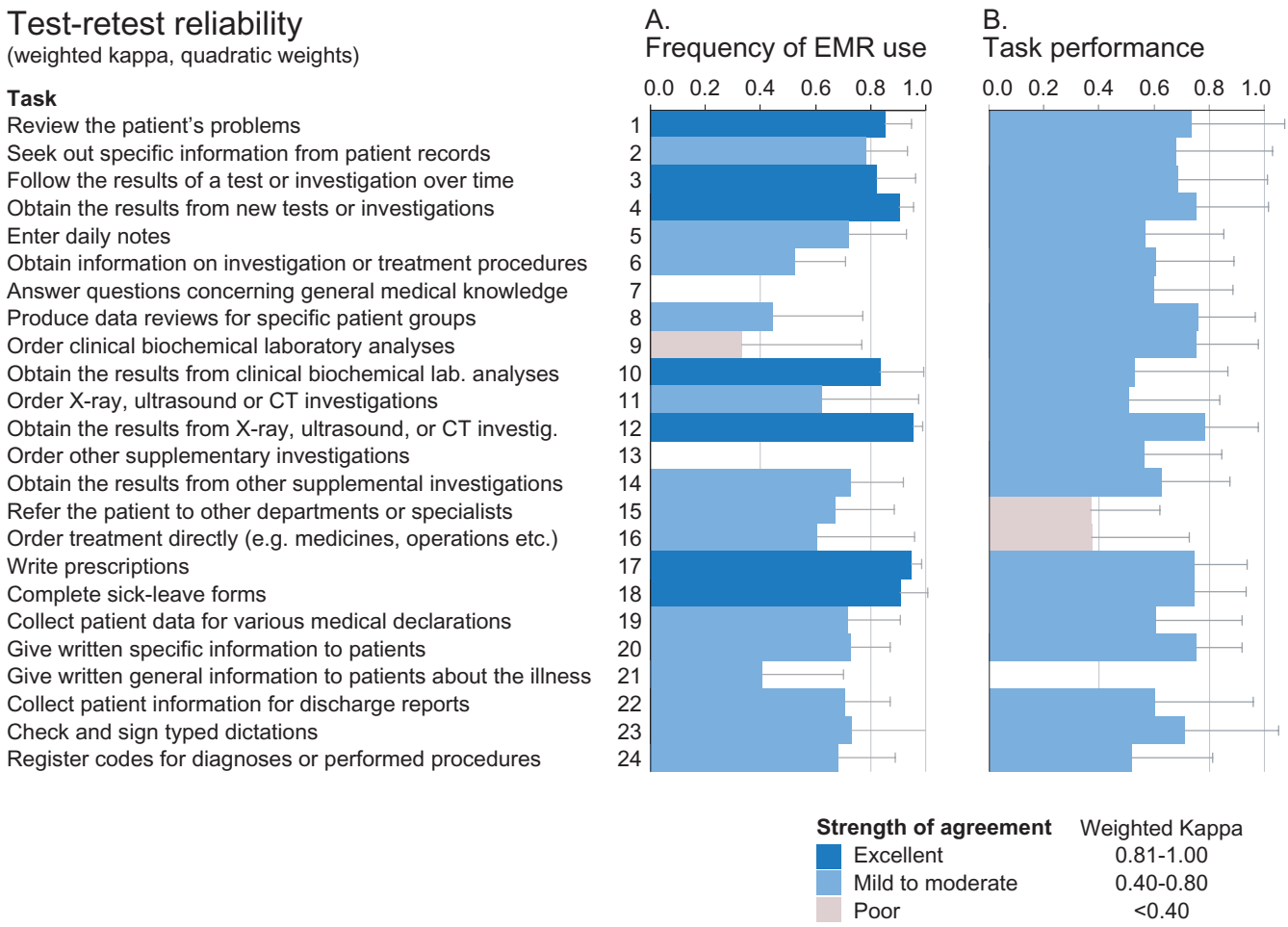



**Figure 3**
**Test-retest reliability** Reliability (weighted kappa, quadratic weights) is shown for task-oriented questions about A) frequency of EMR use and B) task performance. Error bars show confidence intervals of kappa values. Non-significant tests ($p > 0.05$) are hidden.

various EMR systems. In the interviews, the tasks were recognized and correctly interpreted (figure 2) by a wide range of physicians. However, some of the task-oriented questions about EMR use were found difficult to answer, particularly for the higher-level tasks. Four themes appearing in the interviews provided reasons for these problems. First, the respondents were confused when asked about use of EMR for tasks for which no explicit functionality was offered (table 3; theme 3), despite the presence of relevant 'escape' response choices. This confusion may partly explain the contradictory responses in the national survey, where a minor proportion of respondents reported use of the EMR system for tasks it did not explicitly support (tasks 6 and 7)[8], and the low reliability of three questions about EMR use in the test-retest study (tasks 7, 9 and 13). It may also explain the few missing responses in the local study, where unsupported tasks were omitted. As a second problem in describing EMR use, distinguishing EMR from other software or media appeared as a problem in the interviews (theme 4). This problem may explain the many missing responses in parts of the national study (table 4). The reduction of missing responses in the local study suggests that just considering EMR use (and not use of other software) is easier for the respondent. However, the problem will remain for respondents who are using other software than the EMR during clinical work, making reviews of all software available to the physicians necessary. As a third problem, questions about tasks which were not completely supported by the EMR system were found hard to answer, despite the fact that the wording of the questions only implied a supportive role. This problem was in particular attributed to general tasks.

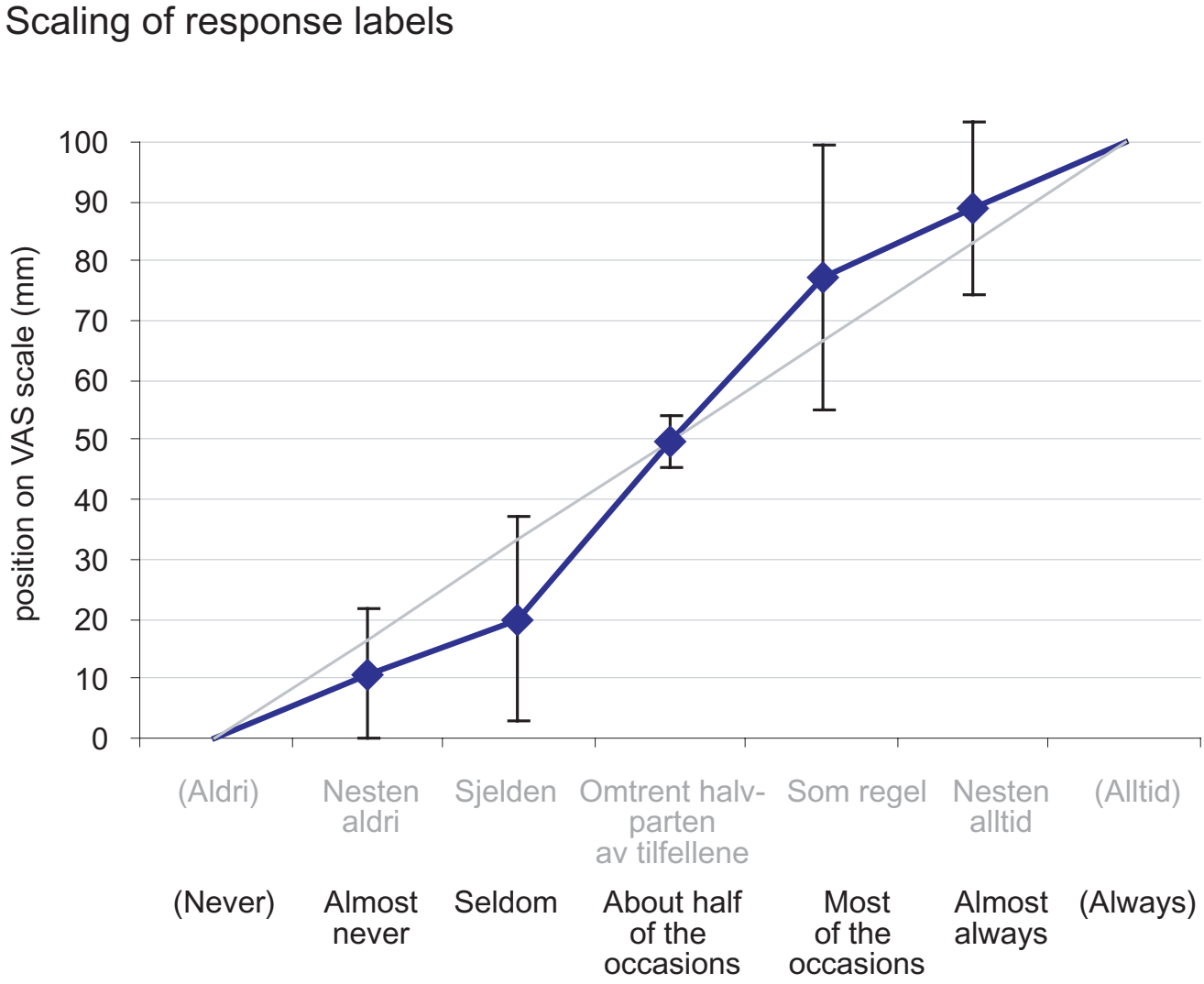



**Figure 4**
**Scaling of response labels** The labels comprise the scale used in the questions about frequency of EMR use. The data points represent measured position on the visual analog scale (mm), and the error bars represent confidence intervals of the sample. The original Norwegian terms are shown in grey color, the English translations in black.

However, the test-retest reliability was relatively high in these questions, suggesting a limited negative effect. Fourth and final, distinguishing other employee's use of the system from one's own appeared as a problem in the interviews (theme 7) in tasks 5 and 15. Regarding task 5 [Enter daily notes], the explanation was confusion about whose use of the EMR should be stated, the physician's or the transcriptionist's. This problem is probably amendable by revising the instructions to the respondent in the questionnaire.

In addition to providing explanations to the findings of the closed questions, the results from the open-ended questions addressed a number of themes on their own. First, wording problems (table 3, theme 2) were expressed particularly for tasks 16, 4 and 21. However, the respondents' interpretations of these tasks (figure 1) were all concordant with and covering essential parts of the task definition. Another important theme involved functionality missed by the respondent (table 3, theme 6), i.e. that the questionnaire did not allow them to express what functionality they were missing in the EMR system. This in particular made it difficult to answer the questions about

user satisfaction, as the respondent had problems deciding whether to provide answers based on the functionality actually available in the EMR system, or on the functionality that should have been in the system. The problem is closely related to the problems regarding EMR only supporting parts of a given defined task (table 3, theme 8).

### *The tasks are relevant for EMR systems*

Moderately high correlations were consistently found between a majority of task-oriented questions and overall questions on EMR use, task performance and user satisfaction. The correlations to self-reported overall EMR use suggest that the tasks are regarded essential to EMR systems as such, and the correlations to work performance suggest that the tasks are regarded important to clinical work. The correlations to user satisfaction agree with the results of both Sittig et al [20] and Lee et al [21], who found significant correlations between user satisfaction and questions about how easily the work was done. In combination, this means that high reported EMR use for individual tasks equals high reported use of the EMR on the whole, and that improved performance of individual tasks equals improved overall work performance and high satisfaction with the system as a whole. Although not proving the validity of each task, it is highly suggestive. Furthermore, the correlations were limited to tasks for which clear functionality existed in the EMR systems. For the uncorrelated tasks, further clarification must await completion of the functionality of current EMR systems.

This way of correlating a set of lower-level task-oriented questions to higher-level questions is commonly used as criterion validation [22]. However, higher-level questions regarding EMR use are difficult to answer, as physicians' work consists of a complex mix of tasks that are suited for computer support and tasks that are not. A more direct form of criterion validation could have been achieved by studying system audit trails [2]. Such trails are readily available, but they must be validated themselves, and they cannot be more detailed than the structure of the EMR system itself. In Norway, the EMR systems are document-based in structure[12]. This limits the interpretation of such trails, particularly when considering information-seeking behavior.

### *The questionnaire produces interpretable results*

The demonstration studies provided readily interpretable results. In the national study, the physicians generally reported a much lower frequency of EMR use than what was expected by the functionality implemented in each hospital[8]. In the local study, the physicians reported a very high frequency of EMR use, mainly for tasks related to retrieval of patient data [12]. In this study, the physicians generally had little choice of information sources, as the paper-based medical records were obliterated in this hospital. The use of the EMR system for other tasks was however much lower. The results from both the national and the local study indicate that the physicians are able to report overall patterns in their use of EMR that is not in line with the implicit expectations signalled by this questionnaire. These results should not be too surprising. The physicians' traditional autonomous position may allow them to withstand instructions from the hospital administration, e.g. regarding ordering of clinical biochemical investigations [23]. Also, in most hospitals having EMR systems, the physicians may freely choose source of patient data. This is due to the fact that both the paper-based and electronic medical record generally are updated concurrently [12], and they are only two of many information sources available in clinical practice (e.g. asking the patient, calling the primary care physician, etc.).

Compared to the 400–600 tasks commonly found in full task inventories [6], the number of tasks in the questionnaire is moderate (24). The high response rates suggest that the number of questions is manageable to the respondents. Compared to that of similar questionnaires [4,21], the task list provides the evaluator with more details about areas for improvement, and it is not designed with one particular EMR system in mind [21]. In addition, more emphasis is placed on clinical use of the EMR system, since the tasks are limited to information-related instead of both practical and information-related tasks [24], and to clinical instead of both clinical and academic work [4]. On the other hand, questionnaires describing self-reported usage patterns have previously been criticized for lack of precision and accountability [25,26]. However, the critics often seem to actually consider poorly validated questionnaires or too optimistic interpretations of them [27], rather than the very principle of self-reporting. When interpreting the results from a survey describing self-reported work patterns, the inherent limitations of self-reporting must be taken into account. Respondents remember recent and extraordinary events much more easily than distant or everyday events, suggesting in our case an over-estimation by those who use the EMR infrequently. Also, in even a systematically validated questionnaire, a considerable degree of bias should be expected towards answers that the respondents believe are expected from them. However, when the responses both fit with the structural premises (i.e. the marked EMR use in the local study, where the paper-based medical record was missing), and defy the implicit expectations (i.e. the lack of EMR use in the national study), the degree of bias seem to be manageable.

### *Reliability and scaling*

The test-retest reliability study generally showed high kappa values both in the section about EMR use and in that of task performance, in spite of some tasks perform-

ing poorly in either section. The poorly performing tasks in the EMR use section addressed functionality that was available to few respondents, while those performing excellently addressed functionality supported by all EMR systems. This means that changes demonstrated for well supported tasks are more likely to reflect real changes in the underlying processes than they are likely to happen by chance. On the one hand, small differences should be interpreted with caution when using the questionnaire, e.g. when significant differences are found in rank values but not in median response values. On the other hand, the evaluator should be careful not to disregard non-significant differences in small samples in the tasks having reliability less than 0.6, as the most likely effect of reliability issues are attenuation of real differences [28].

In the study of the frequency scale (appearing in the questionnaire section about EMR use), the order of the response labels coincide with that of the respondent's visual analogue scale (VAS) markings. In addition, the confidence intervals of the means are clearly separated in this relatively small sample. This suggests that response labels are considered separate steps on an ordinal scale by the respondent. However, the mean VAS values do not increment linearly, but follows a symmetric s-shaped curve, in which the largest increments appear at the middle part of the scale. This suggests that differences in frequency of EMR use might be considered slightly larger when involving or spanning the central label than when involving the labels at each end of the scale. In sum, the scale is ordinal but not linear, making non-parametric methods the best choice for statistical analysis.

#### *Comparing development and evaluation of this questionnaire to that of other questionnaire*

When developing questionnaires, existing literature[22,29] and expert groups[30,31] are commonly used to produce the initial items. For our questionnaire, the literature search was mostly unfruitful, and we had to rely on expert groups and observational work. A common way of structuring the initial collection of items is by identifying latent (and possibly unrelated) variables by performing exploratory factor analysis[22]. For our questionnaire, no factor analysis has been performed. In the national demonstration study, it was due to the considerable differences in implemented functionality between the various EMR systems. In the local demonstration study, it was due to the low sample size relative to the number of questions, i.e. below 10:1 [32]. Although consistent patterns of use (e.g. "the notes reader", "the super-user", "the lab test aficionado", etc.) might be identified by factor analysis, it is unlikely that completely unrelated variables would be extracted from a set of work tasks all designed for the same profession. Work tasks found irrelevant by the physicians could have been identified by analyses of internal consistency among the task-oriented questions, e.g. Crohnbach's alpha[22]. However, such investigations should ask about the work tasks per se, not about tasks for which the EMR system is used, rendering our demonstration studies of little value in this respect. Instead of performing another survey, we chose to explore the tasks as well as the task-oriented questions in a structured interview study. This way, we had an opportunity of explaining why some of the tasks were performing better than the others in the demonstration studies.

When evaluating questionnaires, criterion and content validation is frequently used[29,33]. As the list of tasks in our questionnaire is rather heterogeneous and covers a considerable field of clinical activity, a single global criterion is hard to find. Instead, we used either criteria explaining parts of the task list (e.g. the tasks regarding information retrieval) or indirect criteria based on well-documented relations (e.g. overall user satisfaction vs. task performance).

#### *Limitations of this study*

The questionnaire described in this study applies to physicians only, missing the contribution of other types of health personnel. Further, the list of tasks does not cover communication or planning, suggesting that the list could be augmented in future versions of the questionnaire. Finally, three different revisions of the questionnaire appear in this paper, which might appear confusing. The revisions are however incremental, and should be considered consequences of lessons learned during the demonstration studies.

#### *Application of the questionnaire*

The questionnaire described here may be used as an important part of an EMR system evaluation. Instead of a simple summed score, the questionnaire's task list provides a framework by which EMR systems may be described and compared in an informative way. Since the questionnaire does not provide reasons or hypotheses for the results it produces, surveys involving it should always be accompanied by a qualitative study. The combination of methods will, however, provide more than the sum of its parts. Qualitative studies like in-depth interviews may be probing deeper when the results of the preceding survey are presented to the informant, and observational studies may focus on phenomena explaining the survey results. Conversely, the interpretation of a qualitative study may be aided by the results of a following quantitative study, as it provides a way of weighting the proposed hypotheses.

## Conclusions

The task-oriented questionnaire is relevant for clinical work and EMR systems. It provides interpretable and reli-

able results on its chosen level of detail, as a part of any evaluation effort involving the hospital physician's perspective. However, development of a questionnaire should be considered a continuous process, in which each revision is guided by further validation studies.

## List of abbreviations

EMR Electronic Medical Records

VAS Visual Analogue Scale

## Competing interests

None declared.

## Author's contributions

AF participated in formulating the tasks, designing the questionnaire, performing the demonstration studies and writing this article. HL participated in formulation the tasks, designing the questionnaire, designing and performing the interviews, performing the test-retest and scaling studies and writing this article.

## Additional material

### Additional File 1

*Task list. List of the 24 tasks as they appear in the third revision of the questionnaire, including individual definitions and examples.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S1.xls]

### Additional File 2

*Questionnaire revision 1, Norwegian original version. First revision of the questionnaire, used in the national study.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S2.pdf]

### Additional File 3

*Questionnaire revision 1, English translated version. First revision of the questionnaire, used in the national demonstration study.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S3.pdf]

### Additional File 4

*Data from national demonstration study. Data from the national demonstration study, performed in 2001. The results are published in Lærum H, Ellingsen G, Faxvaag A:* ***Doctors' use of electronic medical records systems in hospitals: cross sectional survey.*** BMJ *2001,* ***323:*** *1344–1348.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S4.xls]

### Additional File 5

*Questionnaire revision 2, Norwegian original version. Second revision of the questionnaire, used in the local demonstration study.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S5.pdf]

### Additional File 6

*Questionnaire revision 2, English translated version. Second revision of the questionnaire, used in the local demonstration study.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S6.pdf]

### Additional File 7

*Data from local demonstration study. Data from the local demonstration study, performed in 2002. Results are published in: H Lærum, TH Karlsen, A Faxvaag:* ***Impacts of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice.*** J Am Med Inform Assoc *2003,* ***10:*** *588–595*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S7.xls]

### Additional File 8

*Questionnaire revision 2, Norwegian original version. Third revision of the questionnaire, used in the test-retest and the interview study in 2003.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S8.pdf]

### Additional File 9

*Questionnaire revision 3, English translated version. Third revision of the questionnaire, used in the test-retest and the interview study in 2003.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S9.pdf]

### Additional File 10

*Data from the test-retest study. Data from the test-retest study, used for the weighted kappa statistic and criterion validity.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S10.xls]

### Additional File 11

*Interview guide, Norwegian Original version. Original interview guide used for the content validation of the questionnaire.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S11.doc]

### Additional File 12

*Interview guide, English Translated version. English, truncated version of the Norwegian interview guide used for content validation of the questionnaire.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S12.doc]

### Additional File 13

*Quantitative data from interview study. Results from closed questions in the interview study.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S13.xls]

## Additional File 14

*Qualitative data from interview study. Norwegian quotes from the interview study categorized into English themes (Norwegian only).*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S14.xls]

## Additional File 15

*Form for scaling study, containing the Visual Analogue Scales. Form used in the scaling study of the Norwegian, modified "frequency of EMR use" Norwegian original version*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S15.pdf]

## Additional File 16

*Data form scaling study. Data from the scaling study of the Norwegian modified "frequency of EMR use" scale.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S16.xls]

## Additional File 17

*Details of development of the questionnaire. The incremental changes in the three revisions of the questionnaire are described here, along with the intentions of the changes.*
Click here for file
[http://www.biomedcentral.com/content/supplementary/1472-6947-4-1-S17.doc]

## Acknowledgements

We thank Peter Fayers for statistical advice, and linguistic and professional support in writing this article.

## References

1. Heathfield HA, Pitty D, Hanka R: **Evaluating information technology in health care: barriers and challenges.** *BMJ* 1998, **316:**1959-1961.
2. Heathfield HA, Felton D, Clamp S: **Evaluation of Electronic Patient and Health Record Projects.** *Volume 2001-IA-533*. Edited by: *HeathfieldHA. England, ERDIP Programme, NHS Information Authority*; 2002:1-80.
3. Gennip E.M.S.J.van, Talmon JL: *Assessment and evaluation of information technologies in medicine / edited by E. M. S. J. van Gennip and J. L. Talmon* Edited by: *GennipEMSJvan and TalmonJL. Amsterdam., IOS Press.*; 1995.
4. Cork RD, Detmer WM, Friedman CP: **Development and initial validation of an instrument to measure physicians' use of, knowledge about, and attitudes toward computers.** *J Am Med Inform Assoc* 1998, **5:**164-176.
5. Wirth P, Kahn L, Perkoff GT: **Comparability of two methods of time and motion study used in a clinical setting: work sampling and continuous observation.** *Med Care* 1977, **15:**953-960.
6. Jacoby I, Kindig D: **Task analysis in National Health Service Corps field stations: a methodological evaluation.** *Med Care* 1975, **13:**308-317.
7. Burkle T, Ammenwerth E, Prokosch HU, Dudeck J: **Evaluation of clinical information systems. What can be evaluated and what cannot?** *J Eval Clin Pract* 2001, **7:**373-385.
8. Lærum H, Ellingsen G, Faxvaag A: **Doctors' use of electronic medical records systems in hospitals: cross sectional survey.** *BMJ* 2001, **323:**1344-1348.
9. Fink Arlene: *The Survey kit / series editor Arlene Fink* Edited by: *FinkArlene. Thousand Oaks, Calif., Sage Publications.*; 1995.
10. Kirwan B, Ainsworth LK: *A Guide to task analysis* Edited by: *KirwanBarry and AinsworthLK. London., Taylor & Francis.*; 1992.
11. Gorman PN: **Information Needs of Physicians.** *Journal of the American Society for Information Science* 1995, **46:**729-736.
12. Lærum H, Karlsen TH, Faxvaag A: **Impacts of scanning and eliminating paper-based medical records on hospital physicians' clinical work practice.** *J Am Med Inform Assoc* 2003, **M1337:**XX-YY.
13. Doll WJ, Torkzadeh G: **The measurement of end-user computing satisfaction - theoretical and Methodological issues.** *MIS Quarterly* 1991, **15:**5-10.
14. Aydin CE, Rice RE: **Social worlds, individual-differences, and implementation - predicting attitudes toward a medical information-system.** *Information & Management* 1991, **20:**119-136.
15. Anderson JG, Aydin CE, Jay SJ: *Evaluating Health Care Information Systems SAGE*; 1994.
16. Sprangers M, Cull A: **Guidelines for moduel development.** *Amsterdam, The Netherlands Cancer Institute*; 1992.
17. Lewis RJ: **Reliability and Validity: Meaning and Measurement.** *Ambulatory Pediatric Association* 1999.
18. Keller SD, Ware J.E.,Jr., Gandek B, Aaronson NK, Alonso J, Apolone G, Bjorner JB, Brazier J, Bullinger M, Fukuhara S, Kaasa S, Leplege A, Sanson-Fisher RW, Sullivan M, Wood-Dauphinee S: **Testing the equivalence of translations of widely used response choice labels: results from the IQOLA Project. International Quality of Life Assessment.** *J Clin Epidemiol* 1998, **51:**933-944.
19. Heggland J: **OntoLog.** *Faculty of Information Technology, Mathematics and Electrical Engineering, NTNU NTNU*; 2003.
20. Sittig DF, Kuperman GJ, Fiskio J: **Evaluating physician satisfaction regarding user interactions with an electronic medical record system.** *Proc AMIA Symp Bethesda, Maryland USA, American Medical Informatics Association*; 1999:400-404.
21. Lee F, Teich JM, Spurr CD, Bates DW: **Implementation of physician order entry: user satisfaction and self- reported usage patterns.** *J Am Med Inform Assoc* 1996, **3:**42-55.
22. Doll WJ, Torkzadeh G: **The measurement of end-user computing satisfaction.** *MIS Quarterly* 1988, **12:**259-274.
23. Massaro TA: **Introducing physician order entry at a major academic medical center: I. Impact on organizational culture and behavior.** *Acad Med* 1993, **68:**20-25.
24. Mendenhall RC, Lloyd JS, Repicky PA, Monson JR, Girard RA, Abrahamson S: **A national study of medical and surgical specialties. II. Description of the survey instrument.** *JAMA* 1978, **240:**1160-1168.
25. Kushniruk AW, Patel VL: **Cognitive computer-based video analysis: its application in assessing the usability of medical systems.** *Medinfo* 1995, **8 Pt 2:**1566-1569.
26. Brender J: **Methodological and methodical perils and pitfalls within assessment studies performed on IT-based solutions in healthcare.** *Virtual Centre for Health Informatics, Aalborg University*; 2002.
27. Nelson EC, Jacobs AR, Breer PE: **A study of the validity of the task inventory method of job analysis.** *Med Care* 1975, **13:**104-113.
28. Rossi Peter H., Wright James D., Anderson Andy B.: *Handbook of survey research Orlando, Academic Press*; 1983.
29. Joshi K, Bostrom RP, Perkins WC: **Some new factors influencing user information satisfaction: implications for systems professionals.** *Calgary, Canada, Special Interest Group on Computer Personnel Research Annual Conference*; 1986:27-42.
30. Doll WJ, Xia W, Torkzadeh G: **A Confirmatory Factor Analysis of the End-User Computing Satisfaction Instrument.** *MIS Quarterly* 1994:453-461.
31. Chin JP, Diehl VA, Norman KL: **Development of an Instrument Measuring User Satisfaction of the Human-Computer Interface.** *NY Association for Computing Machinery*; 1988:213-218.
32. Kerlinger Fred N.: *Foundations of behavioral research : educational and psychological inquiry London, Holt, Rinehart & Winston*; 1969.
33. Friedman Charles P., Wyatt JC: *Evaluation methods in medical informatics New York, Springer*; 1997.

## Pre-publication history

The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1472-6947/4/1/prepub