What makes doctors use the Electronic Patient Record?

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Dit verslag beschrijft de resultaten van de afstudeeropdracht voor de studie Bedrijfsinformatietechnologie aan de Universiteit Twente te Enschede. Het doel van de opdracht was om te ontdekken waarom sommige medische specialisten wel een Elektronisch Patiënten Dossier (EPD) gebruiken en anderen niet.

Het onderzoek wil een antwoord geven op de vraag: *Welke producteigenschappen van een Elektronische Patiënten Dossier en welke gebruikerskenmerken bepalen het succesvolle gebruik door artsen?*
Het onderzoek start met een literatuurstudie over het succes van informatiesystemen, de medisch specialist, het EPD en onderzoeksmethodologie. De literatuurstudie resulteert in de constructie van een conceptueel model dat de relatie tussen gebruikerskenmerken, producteigenschappen en de succesvolle implementatie van een EPD beschrijft. Een tweede resultaat van het onderzoek is constructie van een enquête die de tevredenheid van gebruikers met het EPD meet en de aanpassing van het USE IT-interviewprotocol. Beide instrumenten worden gebruikt in de case studie (veldonderzoek), die als doel heeft het conceptueel model te testen.

Uit de literatuurstudie blijkt dat de tevredenheid van de gebruiker een centrale rol speelt bij het succes van informatiesystemen. De tevredenheid van de gebruiker hangt af van de vier determinanten van het USE IT-model: relevantie, eisen (requirements), weerstand (resistance) en middelen (resources). Relevantie wordt beïnvloed door bruikbaarheid, relatief voordeel, netto opbrengsten en passendheid. Gebruiksgemak, informatiekwaliteit en systeemkwaliteit bepalen de eisen. De weerstand is hoger bij complexiteit en lager wanneer het systeem uitgeprobeerd kan worden en voordelen zichtbaar zijn. Systeemkwaliteit en servicekwaliteit maken deel uit van de middelen.

De medisch specialist kan gekenmerkt worden als een medische professional, die een complexe taak uitvoert, die weinig routinetaken bevat. Hij stelt zijn prijs op zijn professionele autonomie. Het medische proces, zoals uitgevoerd door de medisch specialist is een informatie-intensief proces met hoge onzekerheid en veel waarschijnlijkheden. Het is ook het centrale proces in het hele zorgproces en maakt het opstarten van andere processen mogelijk, zoals b.v. laboratoriumonderzoek en paramedische behandeling. Het patiëntendossier wordt in iedere fase van het medisch proces gebruikt.
De belangrijkste problemen die een medisch specialist tegenkomt zijn tijd-, personeels- en geldgebrek en inadequate patiëntengegevens, met als gevolg het onvermogen om de gewenste kwaliteit van zorg te leveren.

Het belangrijkste doel van het patiëntendossier is om het medisch proces te ondersteunen. Artsen zijn vertrouwd met het papieren dossier, maar dit heeft ook een aantal nadelen. Het belangrijkste probleem is dat er maar één exemplaar van bestaat, dat maar op één plaats tegelijk kan zijn en dat zoek kan raken. Het elektronische patiëntendossier, daarentegen, kan gedeeld worden door verschillende gebruikers, maar kan ook andere functies vervullen, zoals het aanvragen van onderzoeken, beslissingsondersteuning en het tonen van waarschuwingen. De belangrijkste nadelen van het EPD zijn de benodigde investering in tijd en geld, de veranderingen in de werkprocessen en de mogelijke weerstand van artsen tegen het zelf invoeren van gegevens in de computer.

Op grond van deze literatuurstudie een conceptueel model gemaakt, dat de eisen die artsen stellen aan een EPD, beschrijft.

De case studie bestond uit twee delen: 1. het houden van USE IT-interviews met drie medisch specialisten die een EPD gebruiken, met als doel het ontdekken van hun gebruikerskenmerken en 2. uit het houden van een enquête onder negen artsen om de tevredenheid met een EPD te onderzoeken. Op grond van de resultaten van de case studie is het conceptueel model bijgesteld.

Uit het onderzoek kan geconcludeerd worden, dat het leveren van zorg van een hoge kwaliteit aan zijn patiënten, voorop staat bij een arts. Relevantie blijkt het belangrijkste criterium te zijn voor het gebruik en succes van een Elektronisch Patiënten Dossier. Weerstand tegen vernieuwingen of tegen het gebruik van informatiesystemen bestaat nauwelijks, maar het aantasten van de professionele autonomie kan wel weerstand oproepen. Relevantie betekent voor de medisch specialist toegang tot alle relevante patiëntengegevens op ieder moment en iedere plaats binnen het ziekenhuis. De tijd die bespaard wordt op het schrijven van brieven is de 'tastbare' beloning voor het nemen van het besluit om een EPD te gebruiken. Om de implementatie van een EPD een succes te maken voor artsen moet aan drie eisen voldaan worden:

1. Het EPD moet alle relevante patiëntengegevens en functies bevatten op alle werkplekken en 24 uur per dag.
2. Gebruik van het EPD moet passen in het medisch proces van iedere individuele specialist.
3. Verschillende autorisatieniveaus moeten mogelijk zijn binnen het EPD, om de professionele autonomie te beschermen.

Andere eisen die het succes van de implementatie beïnvloeden zijn: ondersteuning van communicatie, aanpasbaarheid aan wensen, minimale leertijd en voldoende ondersteuning van de gebruiker. De toegang tot medische kennisbronnen en tastbare opbrengsten, zoals het besparen tijd bij het opstellen van brieven, worden zeer gewaardeerd, maar zijn niet doorslaggevend voor het behalen van succes. Actieve elementen zoals beslissingsondersteuning en een signaleringsfunctie worden niet gemist. In tegenstelling tot wat verwacht werd op grond van de literatuur, bleek gebruiksgemak en het invoeren van gegevens door artsen geen groot probleem te zijn. De ondervraagde specialisten verwachten echter wel dat dit een vertragende factor bij de verdere invoering bij hun collega's kan zijn.

Summary

This master thesis reports the results of the graduation assignment of the Master of Science[1] study Business Information Technology of the University of Twente in Enschede. The objective of the assignment is to discover the reasons why some medical specialists use an Electronic Patient Record (EPR) in order to reveal why others do not.

The research aims to answer the question: *What product characteristics of an Electronic Patient Record and what user characteristics determine the successful use by physicians?* The research starts with a literature study on the success of Information Systems, the medical specialist, the EPR and research methodology. The literature study leads to the construction of a conceptual model on the relation between user characteristics, product characteristics and the successful implementation of an EPR. Another result of the research is the construction of a questionnaire on user satisfaction with the EPR and the adjustment of the USE IT-interview-protocol. Both instruments are used to perform a case study to test the conceptual model.

From the literature study can be learned that user satisfaction plays a central role in the success of Information Systems. User satisfaction depends on the four determinants of the USE IT-model: relevance, requirements, resistance and resources. Relevance is influenced by perceived usefulness, relative advantage, net benefits and compatibility. Ease of use, information quality and system quality set the requirements. Resistance is enhanced by complexity and reduced by trialability and observability. System quality and service quality are elements of the available resources.

The medical specialist can be characterized as a medical professional, who performs a complex, non-routine job and who values his professional autonomy. The medical process, performed by medical specialists is an information-intensive process with high uncertainty and probability. It is also the central process in the whole care process and enables the start of other processes, like laboratory investigations and paramedical treatment. The patient record is used in every phase of the medical process.
The main problems a medical specialist faces are shortage of time, staff and money, and inadequate patient data, resulting in the incapability to provide the desired quality of care.

The main purpose of the patient record is to support the medical process. The paper record is familiar to physicians, but has some disadvantages. The most important problem is that it consists of a single hardcopy, that can only be in one place at the time and which can get lost. The Electronic Patient Record - on the other hand - can be shared by several users, but can also contain other functions like order entry, a decision support system and clinician reminders. The main disadvantages of an EPR are the needed investment in time and money, the changes in the working process and the possible resistance of physicians to data entry.

Based on the literature study a conceptual model is constructed, which describes the requirements of physicians for the EPR.

The case study consisted of USE IT-interviews with three medical specialists, who use an EPR, to reveal their user characteristics and a questionnaire to investigate the satisfaction with an EPR, which is filled out by nine medical specialists. The case study resulted in the adjustment of the conceptual model.

[1] In Dutch: opleiding tot ingenieur (ir.) in de Bedrijfsinformatietechnologie (BIT).

From the research it can be concluded that a physician's first objective is to provide a high quality of care to his patients. Relevance proved to be the major criterion for the adoption and success of the Electronic Patient Record. Resistance to innovations or the use of information systems hardly exists, but infringement of the professional autonomy can cause resistance. To the medical specialist relevance means the accessibility of all relevant patient data anywhere anytime within the hospital. The time saved on writing letters is the 'tangible' reward for making this decision. To make the EPR-implementation a success for physicians three requirements have to be met:

1. The EPR must contain all relevant data and functions, on all working locations and 24 hours a day.
2. Using the EPR must be compatible with the medical process of each individual specialist.
3. The EPR must allow different levels of authorization to protect the professional autonomy.

Other requirements that influence the success of the implementation are: communication support, customization, minimal time required for training and adequate user support. The access to medical knowledge and tangible benefits like saving time from composing letters are very much appreciated, but are not decisive elements for the success. Active elements like decision-support and clinician reminders are not missed. In contrast with what was expected from literature, ease of use and especially data entry proved not to be a major problem. But the interrogated specialists expect that data entry could slow down the further implementation among fellow specialists.

Preface

I could not have accomplished this master thesis without the loving support of my husband Wim, the cooperation and support of my teachers, coaches and colleagues Robert Stegwee, Ton Spil and Henk Blanken. Many, many thanks!
I also want to thank the physicians of the two hospitals for spending their precious time on talking to me and filling out the questionnaire. My special thanks go to Dick van de Stadt, who inspired me to choose this topic for my research, by his honest and enthusiastic presentation at the National EPR-day in may this year.

Oh, Maarten and Margot, yes, you can use the computer now. Mum finished studying (for the moment).

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Content

1. Introduction

When visiting conferences and meetings about Electronic Patient Records, during the breaks often the complaint is heard that the systems are perfect, and it seems possible to persuade the management to invest in the systems, but how can doctors be made to use them? It seems not so hard to convince physicians to use computer systems for retrieving information like lab results, especially when these results are available much earlier digitally, instead of on paper. But will physicians ever let go of their paper records, share their patient data with others care providers and enter the patient data in the computer themselves?
This perceived reluctance of physicians to actively use computers is hardly documented in scientific literature, but two facts support this feeling: the implementation of Electronic Patient Records in hospitals in the Netherlands proceeds rather slowly (EPD's in Nederland, 2003) and doctors play a central, directing role in the care processes and its information flow (Michel-Verkerke et al., 2003a). Being trained as a physician myself, I can understand why physicians in hospitals would be reluctant to use Electronic Patient Records. First using computers would mean a significant change of working procedures. Instead of walking around between consulting rooms, hospital wards and treatment rooms, taking the patient record that is handed over to you or that is lying on your desk and writing free-text notes in it, you have to sit yourself at a computer-workstation, log on, remember a password, type on a keyboard, scroll and click with a mouse, search the screen for information and enter data in a structured format, while it is not clear what all this effort will bring you.
On the other hand, being also a researcher on ICT in healthcare, I am also convinced of the benefits the Electronic Patient Record (EPR) can bring for patients, nurses, other care providers, but also for physicians. That is why I have chosen to make this subject – the use of the Electronic Patient Record by physicians – the topic of my master thesis. I decided to approach the perceived reluctance of physicians for using the EPR from the opposite side: I did not investigate what hinders physicians from using the EPR, but investigated why physicians do use the system, what makes them do so, what reward do they consider worth the effort? The challenge of the research was to leave the general 'macro'-level of the whole care process, where the benefits of EPR's and other information systems can be easily established, for the 'micro'-level of the individual physician, working in a local hospital, for who the benefits may not be so obvious at all. I hope that the gained insight can be used to make more physicians use the EPR.
In the next sections and chapters I will explain how I performed the research and will account for the used methods, the results and the conclusions. These results may not look very spectacular at first sight, but I hope to show that the key to success is not in advanced technology and spectacular functions, but in getting to know the end-users and their jobs and using this knowledge to design a system that maximally supports each individual user in performing his tasks.

This master thesis reports the results of the graduation assignment of the Master of Science[2] study Business Information Technology of the University of Twente in Enschede. The objective of the assignment is to discover the reasons why some medical specialists use an Electronic Patient Record, while others do not.

The research for this assignment fits in the E-health research program of the Centre for Telematics and Information Technology (CTIT) as performed by members of the department of Business Information Systems of the School for Business, Public Administration and Technology of the University of Twente and other researcher of the University of Twente. The USE IT-tool used in this research is developed and used in previous research in which I was involved. This research comprised the evaluation of the Electronic Prescription System

[2] In Dutch: opleiding tot ingenieur (ir.) in de Bedrijfsinformatietechnologie (BIT).

(Lagendijk et al., 2001), the Multiple Sclerosis health care chain (Michel-Verkerke et al., 2003c) and the TeleCare-project, in which a mobile solution will be developed to improve the communication within the Enschedese Stroke Service (Michel-Verkerke et al., 2003a).

The background of the research is described in section 1.1. Section 1.2 gives the definitions of the two main topics of this research: the medical specialist and the Electronic Patient Record. The research design is presented in section 1.3.

1.1. Research background

The introduction of an Electronic Patient Record (EPR) involves beside technology changes, major personnel and organizational changes (Atkinson and Peel, 1998). In a survey on automation in Dutch hospitals in 1999, a quarter of the responding hospitals reported the use of some kind of Electronic Patient Record in 1999 (Harmsen, 2000). This is about the same as reported in 1996. More than half of the rest had the intention to buy one. This is also about the same as in previous years. So some 40 % of the Dutch hospitals continued to express the desire to use an Electronic Patient Record, without actually implementing one. The recent research performed by Ernst & Young seems to indicate a progress in the last three years, probably due to the introduction of the (obliged) DBC-registration[3]. They report 35% of Dutch hospitals implementing an "informative" EPR in the entire hospital. This "informative" EPR can also be called a "viewing box": it can only be used to view patient data (usually test results, correspondence, etc.), not for data entry (Ernst & Young, EPD's in Nederland, 2003). Only 10% of the hospitals possess an EPR that can register more than DBC's, but it is not known whether these EPR's replace the paper record. The rate of automation in general practices in the Netherlands is much higher than in hospitals: 90% of Dutch GP's[4] use an Electronic Patient Record (Zorg om ICT, 2001). Unfortunately these GP information systems did not keep pace with technological developments and can be regarded as legacy systems.

At the same time a lot of initiatives arose and still arise in the Netherlands to accomplish an Electronic Patient Record (EPR) and other computer-based systems to support patient care. People started enthusiastic and motivated, but unfortunately the results of the EPR-projects are often disappointing (Berg et al., 1998). It proves to be much harder to build a working EPR that meets all demands of the users, than is expected. Technical, organizational, financial, political, and legal obstacles must be faced. For this reason 'EPR' has become a word that evokes mixed feelings in people.
This raises the question, whether the EPR-initiatives in the Netherlands will lead to one or more successful EPR's. And if so, what these EPR's will look like and what characteristics will determine their success.

As was mentioned in the introduction of this chapter, one of the obstacles reported in EPR-implementations is the perceived reluctance of medical specialists to use ICT in general and the EPR especially (Michel-Verkerke, 2003). Since physicians play a crucial role in healthcare, their attitude towards Electronic Patient Records is very important.
Berg (et al., 1998) describe the problems the introduction of a patient-centered paper record gave. The "lack of interest and cooperation on the part of the doctors" in keeping records in a prescribed way is not at all new (Stevens, 1919) cited in (Berg et al., 1998). One of the reasons for the resistance of Dutch physicians is their fear to loose their professional autonomy and their fear for the enlarging influence of hospital management on them (Van de Krogt, 1981). The same cause of resistance seems to hold when discussing the

[3] DBC stands for: diagnosis-treatment-combination (diagnose behandel combinatie in Dutch), a newly introduced system of registration of care processes with financial implications.
[4] GP = general practitioner or family physician. General practices are usually situated in a living area and operate independent of hospitals.

implementation of an Electronic Patient Record. The high percentage of Dutch GP's using an Electronic Patient Record does not contradict this statement. Since GP's work in private practices, using stand-alone systems, the introduction of the EPR does not affect their professional autonomy. The success of the EPR-implementation in general practice is explained by a combination of the support of the professional organization and financial compensation by the government (Zorg om ICT, 2001).
An important other reason for physicians not to use an Information System, is found by Schuring and Spil (2001). They found lack of relevance to be the dominant factor for general practitioners not to use an electronic prescription system.
Drazen (1995) marks resistance of physicians as folklore. She explains differences in user attitude, actual use and user satisfaction by showing the differences in information needs nurses and physicians have and by showing that information needs of physicians differ per specialty and point of delivery of care (inpatient clinic or outpatient clinic).

Whether the resistance is true or not the fact remains that physicians play a key-role in the implementation of Electronic Patient Records. This crucial role of the physician can be explained by the power physicians have. This power is based on several grounds. First, physicians can be characterized as professionals, whose skills and knowledge are defined and controlled by their profession and not by the organization they participate in (Mintzberg, 1979; 1983). Secondly, physicians have formal power: In the Dutch healthcare system, physicians play a central role in patient care. Only they have the authority and power to decide on hospital admission and discharge, referrals, medical treatment, medication and surgery. Paramedical care providers such as physiotherapists; speech therapists and nurses depend on them. Thirdly, physicians also have informal power: Most Dutch physicians are not employees of the hospital but form fellowships that use services from the hospital.

This central position of physicians is the reason for choosing the relation between the physician and more specific the medical specialist working in an outpatient clinic as end-user and the success of an EPR-implementation as the focus in this research. The medical specialist is chosen because his[5] decision to use an EPR greatly affects the success or failure of the EPR-implementation in the entire hospital.
Drazen (1995) suggested research to answer the question: "What features and functions of computer systems are currently acceptable for clinical use, and what improvements are needed to increase the value of these systems?"
With this suggestion in mind, within the focus a choice is made to look at two aspects of EPR-implementations: the product-characteristics of the EPR and the user characteristics of physicians. As will be stated in chapter 2, user satisfaction is essential in Information Systems success. One of the factors that influence user satisfaction is the product (chapter 4). Another factor is the user himself (see chapter 3). For this reason the relation between product characteristics, user characteristics and user satisfaction will be investigated. This will be done by developing a conceptual model which will explain which product characteristics determine the successful use of an Electronic Patient Record by physicians in relation to their user characteristics.

1.2. Definitions

In this chapter the two main concepts of this research will be defined and elucidated: the medical specialist and the Electronic Patient Record. This is done in order to give some insight in the subjects and context of the research. More specific characteristics of the medical specialist, relevant to the research will be given in Chapter 3. Purposes and expectations of the Electronic Patient Record will be discussed in Chapter 4.

[5] although women can be physicians too – myself included – only the male form will be used for legibility reasons.

1.2.1. The medical specialist

A medical specialist is a medical doctor, also called physician, who is trained and authorized to deliver specialty care, such as Internal Medicine, Surgery, Dermatology, etc. Most often medical specialists are ‘independent’ entrepreneurs, but they can also be employees of a hospital. The latter is the case in the academic hospitals, especially. Usually, medical specialists form fellowships with colleagues. These fellowships make contracts with the hospitals about facilities, staff and budgets. Due to legislation and regulation the 'enterprising' medical specialists can hardly be considered as independent. Usually, Dutch medical specialists work in inpatient clinics and outpatient clinics, of one or two hospitals within a limited geographical region.

The medical process

The medical process as performed by a medical specialist during a regular consulting session, starts when a referred patient visits the outpatient clinic (figure 6). The medical process consists generally of eight phases: first the physician reads the available patient information. This information comprises a referral letter of the GP and patient data of previous visits to this medical specialty. When the physician has read the reason for referral he will take the medical history of the patient. The medical history can be followed by physical examination of the patient by the doctor. The combination of medical history and findings during the examination will lead to a preliminary conclusion on what is wrong with the patient and what diseases might cause his or her complaints. This preliminary conclusion is called the differential diagnosis. To set or exclude potential diagnoses a physician can order blood tests, X-rays and other investigations. The first patient encounter usually ends at this moment. When the results of the tests arrive the doctor can set a final diagnosis. Based on this he will make a plan for treatment of the patient. This plan is discussed with the patient in a second encounter, after which the treatment starts. When the treatment is successful the patient is discharged.

1.2.2. The Electronic Patient Record

There are many names and acronyms for computer-based systems in healthcare, such as Electronic Medical Record, Patient Care Information System, Electronic Care Record, Electronic Health Record, Computer-based Patient Record and Electronic Patient Record. This difference in nomenclature often reflects the different points of view of the authors or refers to different levels in functionality of the system.

Although the term Patient Care Information System best expresses its function, i.e. supporting patient care, the term Electronic Patient Record (EPR) will be used in this report, because it is a very commonly accepted term. The definition of an Electronic Patient Record that is used in this research is based on the definition of a computer-based patient record of the Institute of Medicine (Dick et al., 1997):

An Electronic Patient Record (EPR) is a patient record that resides in a computer system specifically designed to support care providers by providing accessibility to complete and accurate patient data, medical alerts[6], reminders, clinical decision support systems, links to medical knowledge and other aids.

This means that an EPR is not just an automated version of the paper record in which patient data are stored, but that an EPR is an active system supporting health care professionals in the care process.

[6] Examples of medical alerts are: a short message to a physician when an alarming lab-result is received or when a physician prescribes a drug to which the patient is allergic.

What is not an Electronic Patient Record?
Since hospitals and other health care organizations use a variety of information systems with overlapping functions, it is sensible to describe which information systems are not considered to be EPR's. Although Hospital Information Systems (HIS) often can be expanded with functions supporting patient care processes, a HIS itself is not considered to be an EPR. The main reason is that its principle purpose is to support the management of health care organizations by supporting the administrative processes. Other systems that can have EPR-functions, but are not considered EPR's itself, are imaging systems (PACS) and laboratory systems (LIMS). As mentioned previously, in this research a specific user group of the EPR will be regarded: the medical specialists in a general hospital. That means that EPR's meant for other user groups - like nursing information systems and patient care information systems used in psychiatric care and rehabilitation centers - will not be investigated in this research.

1.3. Research methods

The objective of the research is to reveal the product characteristics of an Electronic Patient Record that determine the successful use by physicians in relation to their user characteristics. To obtain this result a research question is formulated and a research design is made (Babbie, 1995; Cooper and Schindler, 1998; Heerkens, 2000).

1.3.1. Research question

What product characteristics of an Electronic Patient Record and what user characteristics determine the successful use by physicians?

The research question is made operational in five sub-questions:

1. What factors determine the success of the implementation of an EPR?
   a. What factors determine the success of information systems in general?
   b. When is the implementation of an EPR considered to be successful?

2. What user characteristics of the physician determine satisfaction with the EPR (successful EPR-implementation)?
   a. What are the user characteristics of medical specialists?
   b. What is the influence of user characteristics on user satisfaction and successful implementation of an EPR?

3. What product characteristics of the EPR determine user satisfaction, when the physician is the end-user?
   a. What is an Electronic Patient Record? Functions, purposes, users.
   b. Will there be a common (shared) or generic set of characteristics or requirements the EPR has to meet?
   c. Is it possible to design an EPR that satisfies all user requirements (one size fits all) or that can be adjusted to all requirements of different user groups?

4. In what way do the found product characteristics relate to the found user characteristics? (Construction of the conceptual model)

5. Case study
   a. Are physicians satisfied with the EPR they use?
   b. And if so, why?
   c. And if so, what product characteristics of the EPR satisfy them?
   d. What user characteristics apply to the physicians?
   e. Does the model explain success or failure of an EPR-implementation among physicians in the investigated cases?

1.3.2. Research design

The research design is depicted in figure 1. First a literature study is performed on four topics:

a. The theory on success of information systems (sub-question 1, chapter 2),
b. The user characteristics of the medical specialist (sub-question 2, chapter 3),
c. The purposes, functions and product characteristics of the Electronic Patient Record (sub-question 3, chapter 4) and
d. The theory on performing a case study and the construction of a questionnaire (chapter 5).

The literature study results in a conceptual model on the relation between user characteristics, product characteristics and successful implementation (chapter 5), and in the construction of a questionnaire to test this conceptual model in a case study (chapter 5 and appendix C). To test the hypotheses on user characteristics and the medical process the existing USE IT interview-protocol is adjusted (chapter 5 and appendix B). The questionnaire and the USE IT interview-protocol are used to perform the case study; the results are described in chapter 6. From the case study conclusions are drawn and the conceptual model is evaluated and adjusted (chapter 7). Also suggestions for future research are formulated based on the results of the research (chapter 7).

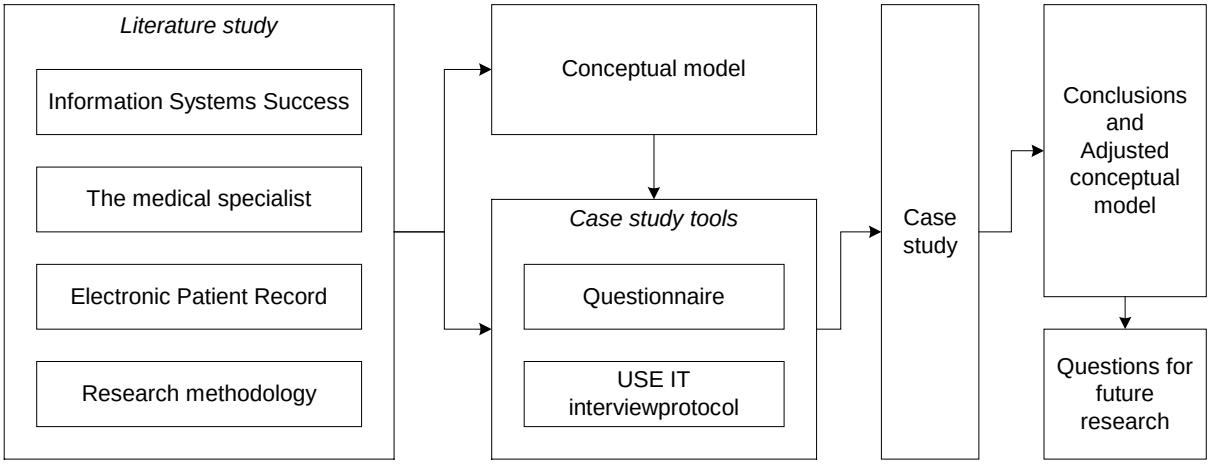

Figure 1. Research design.

The chosen research approach combines theory with empirical data, but also the human perspective with the technological perspective. This means that a detailed requirements analysis – as the first phase of the information system life cycle (Pressman and Ince, 2000) – will not be performed, because this will only reveal the ideas of the user about the product; it will not reveal the characteristics of the user that influence the success of the implementation (see chapter 2), nor the relation between the user characteristics and the product characteristics. The same argumentation holds for the use of tools to enhance (Pressman and Ince, 2000) user-involvement in the system development or implementation, developed by the social sciences. These tools help the users to realize their requirements, without investigating the relation between their own characteristics and the system. That is why two tools will be developed or adjusted based on Information Systems success-theory, which are together able to reveal product and user characteristics and their relation. The outcome of this could result in the wish to perform a detailed requirements analysis, but that will not be part of this research.

1.3.3. Value of the research

The conceptual model can serve as an instrument for explaining success and failure of use of Electronic Patient Records by physicians as far as this success or failure is influenced by the product and user characteristics, and by that the research shows its scientific contribution. But the conceptual model also has a practical value, since it can be used for advice by guiding choices to be made about product characteristics of Electronic Patient Records for certain medical specialist-users.

2. What factors determine the success of Information Systems?

This chapter deals with the first research question:

What factors determine the success of the implementation of an EPR?
a. What factors determine the success of information systems in general?
b. When is the implementation of an EPR considered to be successful?

First the definition of success used in this research will be given. Then the theory on diffusion of innovations and success of Information Systems will be discussed to reveal what factors determine the successful implementation of information systems as far as the product and the user are involved. The outcome of this part of the literature study will be used in the construction of the conceptual model and the questionnaire for the case study. In this chapter special attention will be given to the USE IT-model, since it will also be used in the case study.

2.1. Definition of success

According to the dictionary (Geerts et al., 1984; *Collins*, 1995) success can be defined as the achievement of an aim or the attainment of wealth, fame or position. As will be argued in this chapter, the main aim to be achieved by implementing an information system is to satisfy users, who use the information system, when performing their daily tasks.
Berg (2001) offers different definitions of success: success could mean the actual use of a system, but also the appreciation of this use by the users or their managers. When discussing success it must be clear what criteria or parameters are used to measure success. He regards success as a dynamic concept, since the view – and by that the criteria – on what success is, might change in time.

In this research the success of a specific ICT-product: the Electronic Patient Record (EPR) is discussed from the perspective of a specific user group: the medical specialists. For that reason a successful EPR-implementation will be defined in this research, as follows:

An EPR-implementation is considered to be successful if the physician uses the EPR when performing his core tasks and when he is satisfied about this use.

The literature study that is presented in the next sections will lead to a list of factors that are considered to be essential in accomplishing a successful EPR-implementation.

2.2. The innovation process and the product

Different ways to look at the innovation process exist. The first way that is presented here is the view of Larsen (1998), because it gives a good overview of what factors and elements are involved.

Larsen (1998) states that: "Elements of IS innovations include technical issues, human concerns, managerial actions and knowledge, interactions among line employees and information technology (IT) experts, strategic, tactical and operational requirements, organizational elements, and vision." This means that a holistic vision is needed to analyze IS success. "The quality of the IS/IT product is a necessary but not sufficient prerequisite for IS innovation success. The *people* within the organizations determine the outcome."

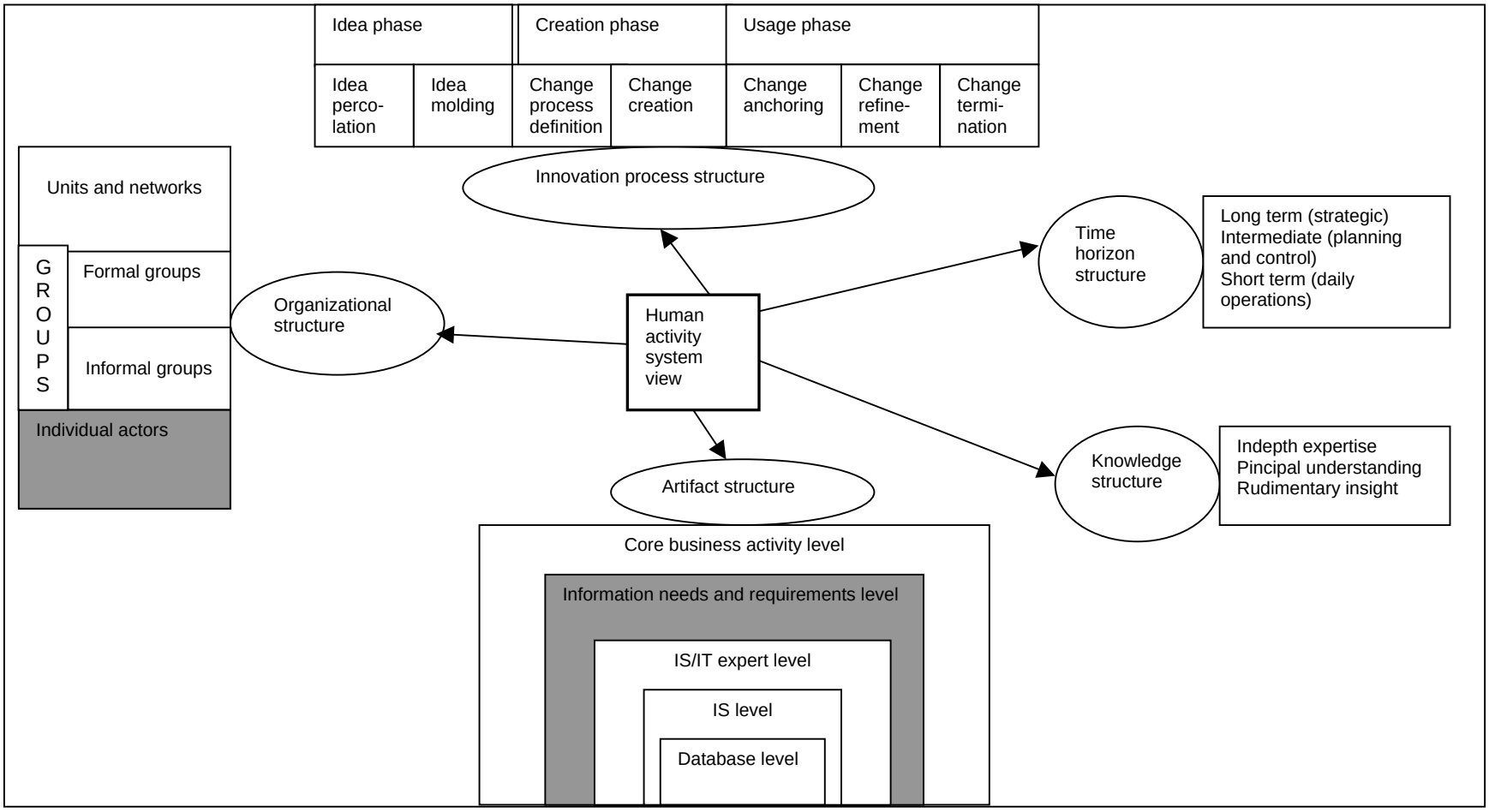

Figure 2. The IS Innovation Framework: key Issues Structure (Larsen, 1998)
Innovation process structure: this also comprises the project management, because an IS-innovation changes over time.
Knowledge structure: this concerns the IS-knowledge of managers and the business-knowledge of the IS-experts.
Organizational structure: Units en networks make the formal organization. The formal group is the power elite who uses innovations to realize their own objectives; informal groups often introduce changes. Individuals often initiate change.
Artifact structure: the artifact is not only the IS, but also the people's visions and objectives connected with the IS.
The marked boxes position the present research.

The framework for IS innovation Larsen (1998) presents, is meant as “checklist to map the elements actors include in their innovation undertakings and increase the awareness of IS innovation aspects yet not considered". The elements are categorized in five structures: the innovation process structure, the organizational structure, the time horizon structure, the knowledge structure and the artifact structure. The framework is used to position this research and the discussed IS-success literature. The boxes marked in figure 2 show that this research deals with individual actors on the information needs and requirements level.
Larsen does not say which elements or structures have a greater or lesser influence on the human activities, nor does he say which aspects enhance success.

The relation between the different structures is described by Rogers (1995) in his book on diffusion of innovations. Rogers studied the adoption of existing innovations (and much less the development of innovations) and the decision-process that is involved. The innovation-decision process described by Rogers affects four of the structures mentioned by Larsen: the innovation process structure, the organizational structure, the artifact structure and the knowledge structure, but not the time horizon structure.
Rogers distinguishes five stages in the innovation-decision process (see figure 3): knowledge, persuasion, decision, implementation, and confirmation. *Knowledge* occurs when an individual is aware of an innovation’s existence and its functions. *Persuasion* means that an individual forms a favorable or unfavorable attitude towards the innovation. *Decision* occurs when the individual engages in activities that lead to a choice to adopt or reject the innovation. *Implementation* is the use of an innovation. *Confirmation* occurs when an individual seeks reinforcement of an innovation-decision already made, or reverses a previous decision to adopt or reject the innovation.
The persuasion stage (stage II) is characterized by: relative advantage, compatibility, complexity, trialability and observability. *Relative advantage* is the degree to which an innovation is perceived as being better than the idea it supersedes. *Compatibility* is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters. *Complexity* is the degree to which an innovation is perceived as relatively difficult to understand and use. *Trialability* is the degree to which an innovation may be experimented with on a limited basis. *Observability* is the degree to which the results of an innovation are visible to others. Relative advantage, compatibility, trialability and observability are positively related to the rate of adoption, complexity negatively.
Re-invention, which is defined as the degree to which an innovation is changed or modified by a user, is an important issue in the implementation stage (see figure 3, stage IV) (Rogers, 1995).

According to Rogers (1995) the innovation-decision process is an individual process, influenced by peers: “An individual is more likely to adopt an innovation if more of the other individuals in his or her personal network have adopted previously”. This influence of peers is not confirmed by Chismar and Wiley-Patton (2003) for physicians. As will be discussed in Chapter 3 physicians are professionals, who can make their own decisions in many issues.
Even if the innovation is imposed upon the end-user by the organization, it is the individual end-user, who decides whether to use the innovation, to what extent and in what way. Also people with little or no formal power do have power from personal sources (such as expertise, effort, persuasion and manipulation) and position sources (such as physical location, information flow and access) (Daft, 1998). In the innovation diffusion process, this power will be mainly power to resist or to enhance, not the power to start an innovation (Rogers, 1995).

Ease of use is the opposite of the complexity, mentioned by Rogers (1995). Davis (1989) investigated the relation between perceived ease of use, perceived usefulness and self-reported usage.

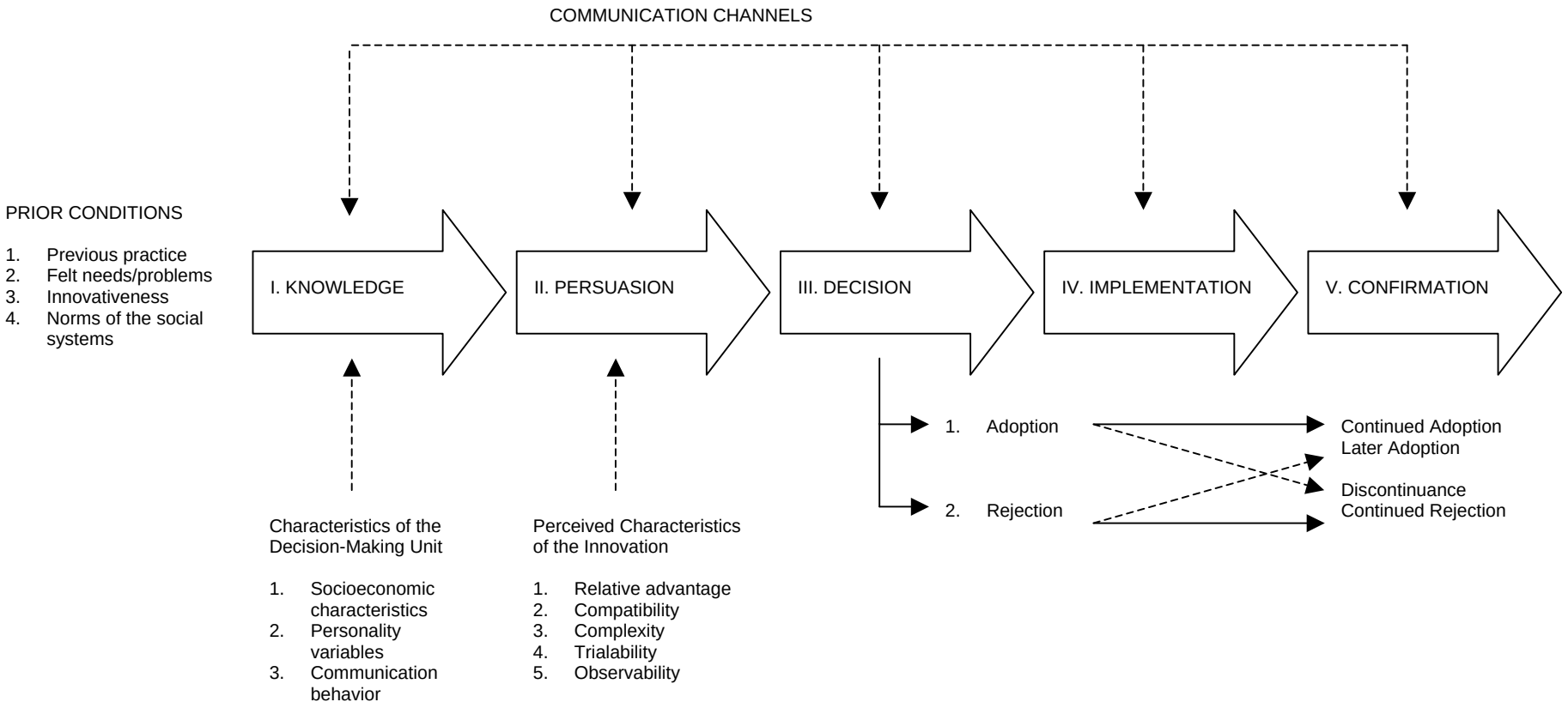

Figure 3. A Model of Stages in the Innovation-Decision Process, derived from (Rogers, 1995)
The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

Perceived usefulness is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance”. Perceived usefulness can be regarded as an element of relative advantage, as defined by Rogers (1995). Davis found that the perception of ease of use and usefulness by the users, are more important than objective measures of these factors. His conclusion is that the actual use of a system highly correlates with perceived usefulness and hardly with ease of use. “Users are often willing to cope with some difficulty of use in a system that provides critically needed functionality. Although difficulty of use can discourage adoption of an otherwise useful system, no amount of ease of use can compensate for a system that does not perform a useful function.” Ease of use on the other hand seems a prerequisite for considering the usefulness. Davis’ results “are consistent with an ease of use → usefulness → usage chain of causality” (Davis, 1989).

McGowan and Madey’s research on EDI-implementation[7] showed that factors that influence the adoption-decision differ from the factors that influence the success of the implementation (McGowan and Madey, 1998). The decision to adopt EDI was highly influenced by the customer’s demands to do so. After the adoption decision was made the organization changed its processes to make the EDI-implementation successful.

So Larsen pictures the elements that should be considered in the innovation process and Rogers describes what factors influence the decision to adopt an innovation. But what factors determine the success of this adoption?
One model to explain success is the reformulated model of IS success of DeLone and McLean. In this model DeLone and McLean give a central role to the user by the variables user satisfaction and use (see figure 4) (DeLone and McLean, 2002). To use the model to measure success it is necessary to define from which point of view the measurement will take place. Like Berg (2001) DeLone and McLean state that this view is defined by the stakeholder and by the type of system involved. But whatever stakeholder or system is chosen, the nets benefits depend on the use and user satisfaction.

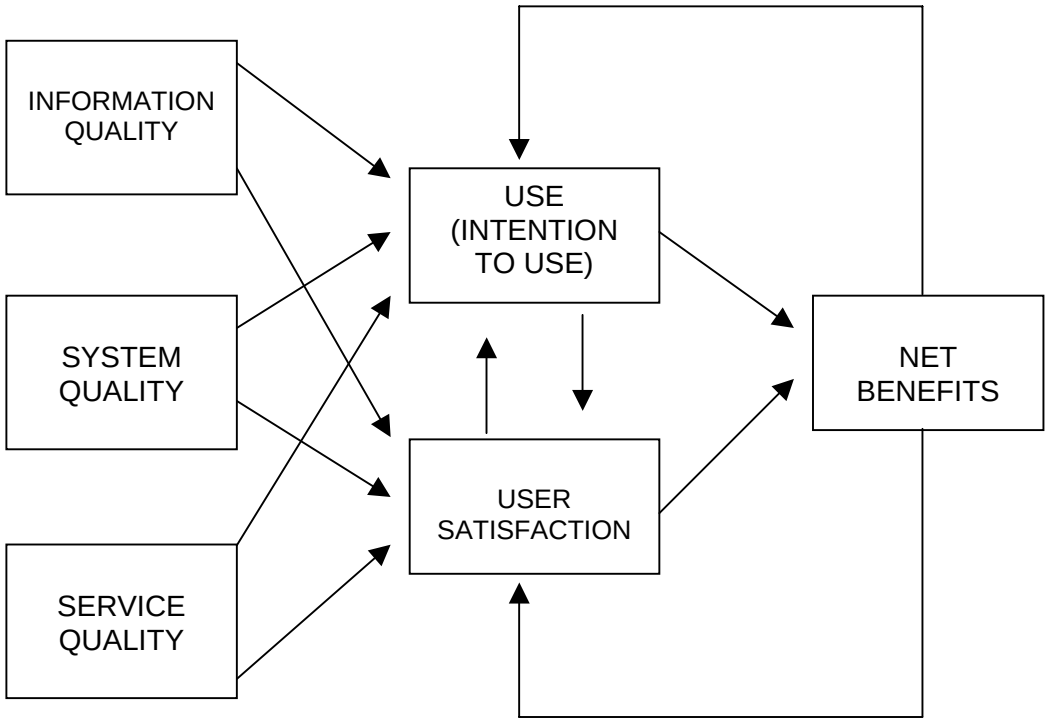

Figure 4. The Reformulated IS Success (DeLone and McLean, 2002)

[7] EDI = Electronic Data Interchange, a method of electronic exchange of messages.

These two interdependent factors play a key role in IS success: net benefits will not be established without use and user satisfaction which factors are reinforced by achieved net benefits. Considering the innovation-decision process of Rogers, one could say that the expected relative advantage in the persuasion stage must become true to lead to continued adoption in the confirmation stage (figure 3). In the model of DeLone and McLean use and user satisfaction both depend on three other factors: information quality, system quality and service quality. These three qualities can be seen as aspects of the IS-system or strongly related to it. In this way these factors can be characterized as product quality. When placed in the framework of Larsen DeLone and McLean only consider the artifact and innovation process structure (see fig 2).

Complying with DeLone and McLean, Garrity and Sanders (1998) consider user satisfaction as the main criterion for IS-success. From their research Garrity and Sanders conclude that user satisfaction can be measured by measuring the dimensions: task support satisfaction (including decision-making satisfaction), quality of work life satisfaction and interface satisfaction. These dimensions are the basis for the questionnaire that is used in the case study of this research to measure the satisfaction of physicians with the Electronic Patient Records. The questionnaire is further discussed in chapter 5.

Another view on the success of information systems is demonstrated by Saarinen and Sääksjärvi (1992). They state that the success of an information system depends on the success of both the process and the product (figure 5). Process success is determined by success of the development process and by success of the use process. Quality of the IS product and impact of the IS on the organization result in product success.

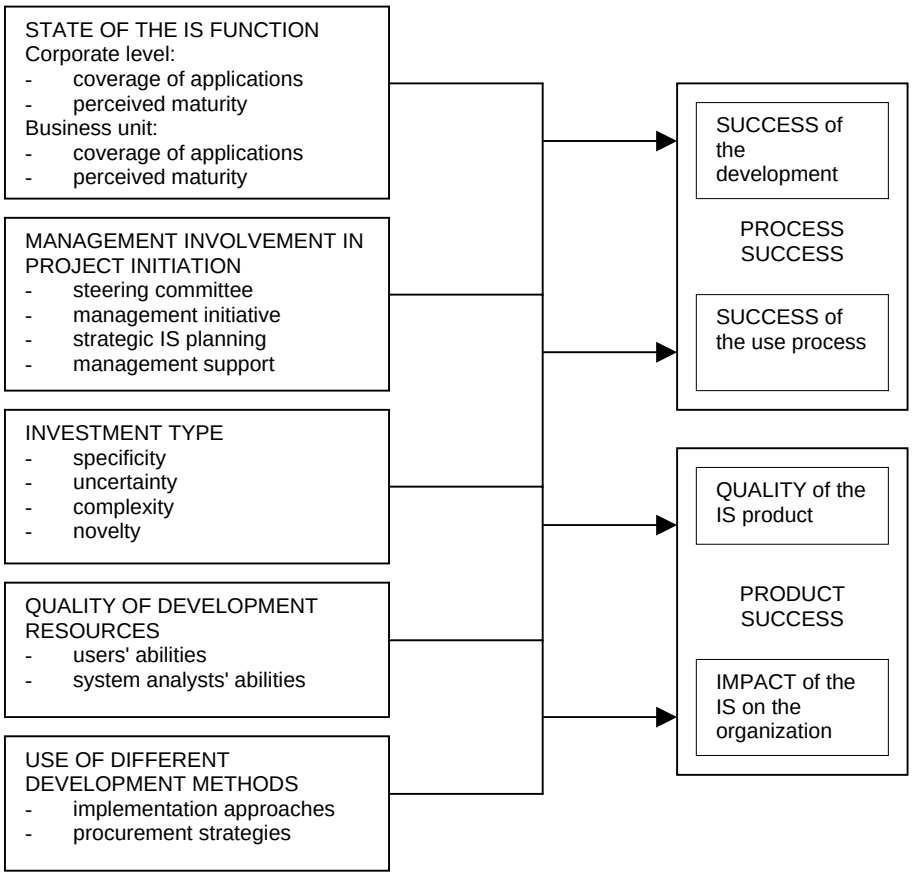

Figure 5. Framework of factors affecting different success criteria in an IS development project (Saarinen and Sääksjärvi, 1992).

The development and use process can be linked with the innovation process structure of Larsen's framework. The quality of the IS product is influenced by the artifact structure and the impact of the IS on the organization is affected by the organization structure (figure 3). Saarinen and Sääksjärvi (1992) also found that factors affecting process success differ from factors affecting product success and, showed that factors explaining success differ from factors explaining failure. Projects succeeding well in the use process can be characterized by a mature IS function (matching with service quality mentioned by DeLone & McLean), high level of management support, high experimentation rate (matching trialability mentioned by Rogers) and high level of using outside resources. Features of failures in the use process are: project initiated in a strategic IS planning project, system with high specificity, high requirements uncertainty (both related with complexity mentioned by Rogers) and use of software packages.

In summary one could say that a potential user of an Information System decides to start using the system because he expects the system to be useful to him and to bring him some kind of advantage and that he will continue to use the system when he is satisfied over the system and the benefits it brings. The success of the information system can be measured by measuring the user's satisfaction over the system. In this approach a causal relation is suggested between the quality of the system (in this research: the EPR) and the success of the system for a certain group of users (in this research: medical specialists). To test this relation a questionnaire is constructed that measures the actual use, the user satisfaction and what elements of the EPR cause this satisfaction (see chapter 5).

In the next section the angle from which will be looked will shift a little. The presented USE IT-approach focuses much more on the user of the system than on the information system itself. Both approaches are used in the case study (chapter 6).

2.3. The USE IT- model

In their USE IT-model to predict and evaluate success of Information Systems Schuring and Spil (2003) present two dimensions: the innovation-dimension and the domain-dimension, which make four determinants for success: relevance, requirements, resistance and resources.

USE IT-model	*User Domain*	*Information Technology Domain*
Product	Relevance	Requirements
Process	Resistance	Resources

Table 1. The USE IT-model (Michel-Verkerke et al., 2003b)

With the process the innovation process is meant, similar to the process defined by Saarinen and Sääksjärvi (figure 6) and the innovation process structure of Larsen (figure 3). The product is the result of this innovation process. This corresponds with the definition of the product by Saarinen and Sääksjärvi (figure 6) and the artifact structure in the framework of Larsen (figure 3). Also the IT domain is part of the artifact structure; the user domain represents the organizational structure in Larsen's framework. The time horizon structure can be part of the requirements and the knowledge structure can be considered as an element of the resources.

The four determinants each are defined on two levels: the macro-level and the micro-level. The macro-level represents a general perspective e.g., the organizational level. The micro-level refers to the individual user.

The *relevance* determinant is defined by Schuring & Spil (2003) as: *"the degree to which the user expects that the IT-system will solve his problems or help to realize his actually relevant goals".* The word "expects" expresses that relevance is a factor that is important in the course of the adoption process, not only in evaluation. The word "actually" is crucial in their view of relevance. Relevance is not to be confused with the degree to which the user considers outcomes as being positive. The set of outcome-dimensions that someone considers "positive" is larger than the set of outcome-dimensions that are relevant. Imagine a physician, who basically considers IT-outcomes of a computer decision support system, such as, assistance in diagnosis, disease prevention, or more appropriate dosing of drugs, as "positive". This does not automatically imply that the IT-adoption is relevant to him; it is only relevant if these dimensions are high on his "goal agenda". Macro-relevance comprises economic, social, functional improvements and saving time and effort. An innovation is micro-relevant when it solves the here-and-now problems of the individual user.
Relevance defined in this way comprises perceived usefulness (Davis, 1989), relative advantage, high compatibility (Rogers, 1995), net benefits (DeLone and McLean, 2002), and job relevance (Chismar and Wiley-Patton, 2003), and results in task support satisfaction, which is a criterion for user satisfaction (Garrity and Sanders, 1998).
In their study on the implementation of an Electronic Prescription System Schuring and Spil found that lack of relevance was the major determinant that explained the failure of the implementation (Schuring and Spil, 2001).

Resistance is the personal attitude of all stakeholder groups towards the introduction of an information system (Spil, 2003). Macro-resistance depends on the opportunity to change. The main aspect of micro-resistance is the attitude and the willingness to change. Pare and Elam (1999) also focus on the attitude of the professional when they assess clinical information systems. The end users have an important role because their norms and values determine the effectiveness of the information system. Resistance was found to be the cumulative effect of the other three determinants (Schuring and Spil, 2001).
Expectance of reduced quality of work life satisfaction, high complexity and the lack of trialability can result in resistance (Rogers, 1995; Garrity and Sanders, 1998). Observability reduces resistance (Rogers, 1995).

Requirements are defined *as the degree to which the user needs are satisfied with the product quality of the innovation* (Spil and Schuring, 2003). Macro-requirements comprise strategic general requirements and the chosen approach of innovation process. Functional and performance requirements are considered to be micro-requirements.
Perceived ease of use is a prerequisite according to Davis (1989). Meeting the end-user's requirements results in high information quality, system quality (DeLone and McLean, 2002) and high interface satisfaction (Garrity and Sanders, 1998).

Resources are defined *as the degree to which material and immaterial goods are available to design, operate and maintain the information system* (Spil and Schuring, 2003). The main focus of the determinant resources will be on the people and on the costs these people cause. Next to that the reliability of the information technology and the information systems are considered.
Resources defined in this way refer to service and system quality (DeLone and McLean, 2002), management support and mature IS function (Saarinen and Sääksjärvi, 1992).

To measure the determinants the USE IT-tool consists of structured interviews. In this way a more precise insight can be obtained in the nature and relevance of problems and solutions, before implementation and this insight can be tested with the same tool during the evaluation of the implementation. In this research the USE IT-tool is used to measure what aspects of the four determinants are important in the selected user group (medical specialists) in order to understand why users are satisfied about the specific system (EPR).

Since the focus in this research is on the relation between product and user characteristics, most attention will be paid on relevance and little to resources. Also will the focus be dominantly on the micro-level.

2.4. IS-success theory applied to the research

The previous discussed IS-theory shows the central role of the user in the success of IS/IT-products. This may seem very obvious and appear as common knowledge, but until now the implementation of this knowledge proves to be hard and has not lead to a guaranteed successful "recipe" for the implementation of Information Systems. Several tools to involve the user in the development and implementation process have been developed (Mumford, 1983; ANSI/IEEE 830, 1984; Pressman and Ince, 2000). The difference of the USE IT-tool with these tools is that it can be used to make a "diagnosis" / evaluation *before* starting the development or implementation, and but also to evaluate the implementation of the implementation (Michel-Verkerke et al., 2003b).

The factors that influence the user's satisfaction with the system according to the previous discussed literature are summarized in table 3. The construction of table 3 is the first step in constructing the conceptual model. The case study will show whether the presented theory on success of Information systems also applies to the successful implementation of an EPR.

Factors that enhance user satisfaction	**Must be:**	**Reference**
Relevance	*High*	*(Schuring and Spil, 2003)*
Perceived usefulness	High	(Davis, 1989)
Relative advantage	High	(Rogers, 1995)
Net benefits	High	(DeLone and McLean, 2002)
Compatibility	High	(Rogers, 1995)
Requirements	*Met*	*(Schuring and Spil, 2003)*
Ease of use	High	(Davis, 1989)
Information quality	High	(DeLone and McLean, 2002)
System quality*	High	(DeLone and McLean, 2002)
Resistance	*Low*	*(Schuring and Spil, 2003)*
Complexity	Low	(Rogers, 1995)
Trialability	High	(Rogers, 1995)
Observability	High	(Rogers, 1995)
Resources	*Sufficient*	*(Schuring and Spil, 2003)*
Service quality	High	(DeLone and McLean, 2002)

Table 3. Factors that enhance user satisfaction.
The USE IT-determinants are in italic. The factors are ordered according to the related USE IT-factor. This ordering is not strict but meant to show some comprehension.
* System quality is also an element of the resources.

3. What user characteristics characterize physicians?

In the previous chapter is shown that IS-success largely depends on the satisfaction of the end-user with the system. In this chapter a closer look will taken on this end-user and his job. Who is this physician and how does he work and how does he make adoption-decisions?
The subject of this chapter will be research question 2:

What user characteristics of the physician determine satisfaction with the EPR (successful EPR-implementation)?

a. *What are the user characteristics of medical specialists?*
b. *What is the influence of user characteristics on user satisfaction (successful implementation of an EPR)?*

To answer these questions the two determinants of the user domain of the USE IT-model: relevance and resistance will be discussed. In the first session the power of the medical specialist to resist will be discussed. In the second session a closer look will be taken on the professional work of the physician in order to reveal the relevance of an Electronic Patient Record for him.

3.1. The medical specialist: the power of the professional

Resistance to innovations or ICT in general is probably not greater among physicians than among other people. Physicians have adopted many innovations in medical practice. Also physicians have initiated many ICT-projects. Nevertheless resistance to the implementation of EPR's is experienced in practice and complained about.
Especially data entry seems to cause resistance (Michel-Verkerke, 2003). According to the Institute of Medicine study, "perhaps the single greatest challenge that has consistently confronted every clinical system developer is to engage clinicians in direct entry." (Dick et al., 1997). And Van Ginneken and Moorman (1997) state, that clinicians "appear to be reluctant to enter data directly into a computer, because they felt that data entry on a terminal would be time-consuming and unfriendly to the waiting patient". The notes of specialists are extensive and detailed. "Hence, the interactive use of a Computer-based Patient Record may be … time-consuming for a specialist" (Van Ginneken and Moorman, 1997).

Another source of resistance can be the fear for infringement of the professional autonomy. As is described in Chapter 1 physicians in the Netherlands hold a central and powerful position in healthcare. First, medical specialists working in a hospital can be characterized as professionals working in a professional bureaucracy, whose skills and knowledge are defined and controlled by their profession and not by the organization they participate in (Mintzberg, 1979; 1983). These professionals are rather autonomous regarding the way they plan and perform their complex and non-routine jobs. The hospital organization has a supportive function towards the medical professionals, who are – by definition – hard to control and manage. Often tension exists between the professionals and the top management (Mintzberg, 1979; Jägers et al., 1995). Van der Krogt (1981; 1991) describes the power that follows from the professional's position in an organization. This power is based on the knowledge and skills that are exclusive for the profession, the value the professionals have for the organization and their central position in the organizational processes. Especially the professional organizations defend this value (Van der Krogt, 1981).
One of the changes an EPR brings is that the patient record is no longer 'owned' by the physician. Not only other physicians, but also all care providers involved with the care for one patient might view the entered data and get insight in the way a physician works.

The fear of intrusion of insurance companies and the fear of governmental control on medical practice had (and still has) a great influence on the development of health care in the Netherlands (Van der Krogt, 1981; Berg et al., 1998)

This professional position of medical specialists also explains why the decision to implement an Information System, such as an Electronic Patient Record is an autonomous decision made by the individual medical specialist and his fellows and can hardly be imposed by the hospital management or the government. As is discussed in the previous chapter, the decision to adopt or reject an innovation is influenced by a great many factors of which relevance is a dominant one. Whether peers, like the fellow medical specialists influence the individual decision is not clear (Rogers, 1995; Chismar and Wiley-Patton, 2003; Schuring and Spil, 2003).

Secondly, physicians have formal power: In the Dutch healthcare system, physicians play a central role in patient care. Only they have the authority and power to decide on hospital admission and discharge, referrals, medical treatment, medication and surgery. Paramedical care providers such as physiotherapists; speech therapists and nurses depend on them (see also 3.2 and figure 8). This means that the adoption-decision of physicians has great consequences for the rest of the health care providers and the hospital organization because of the central position of physicians in the health care process.

Thirdly, physicians also have informal power: Most Dutch physicians are “independent” entrepreneurs joined in fellowships that use services from the hospital. The relation between hospital management and the physicians is neither hierarchical, nor a strict supplier-client relation, but rather complicated and strongly influenced by political power (Fehse et al., 2001). This power is also historically grown. The autonomy of physicians as entrepreneurs has been and still is defended by the professional organizations and is to a large extent respected by the government and hospital organizations (Van der Krogt, 1981; Berg et al., 1998). As was expressed by a representative of the Order of Medical Specialists in 2002: What medical specialist really want is to be in the lead, meaning that a. ICT must support their work, b. he decides about priorities and c. he decides about the content. He also wants a local solution (Naber, 2002).

3.2. The medical process

The primary process performed by the medical professional is a complicated, non-routine process with high uncertainty and probability (Tang and McDonald, 2001). Figure 6 shows the medical process as performed by the medical specialists. This process model is a general model. In each patient-doctor-encounter the process can proceed in a different way. Steps can be skipped or repeated and information needs and produced output can differ, but this difference is mainly a matter of detail or completeness of the information and not a matter of different nature of information. The course of the process depends on the disorder of the patient and on the specialty of the physician. Internists, e.g., often treat complex disorders that are being diagnosed by excluding specific causes or diseases and by ranking probabilities. Diagnosing in such cases is a continuous process of reasoning and reconsidering earlier conclusions. In this continuous process it is essential to record not only the results of the reasoning process, but also the arguments and hypotheses. In surgery the diagnosing process is often less complicated, based on physical examination and e.g., X-ray. But here it is important to record all deviations of normal operating procedures.
A third factor influencing the medical process is the physician's attitude towards his work. A physician who wants to be sure not to overlook serious disorders (like cancer), will order much more tests and record his choices much more detailed, than a physician who considers the chance of harm done by extensive examining greater than the chance of harm caused by a missed disorder.

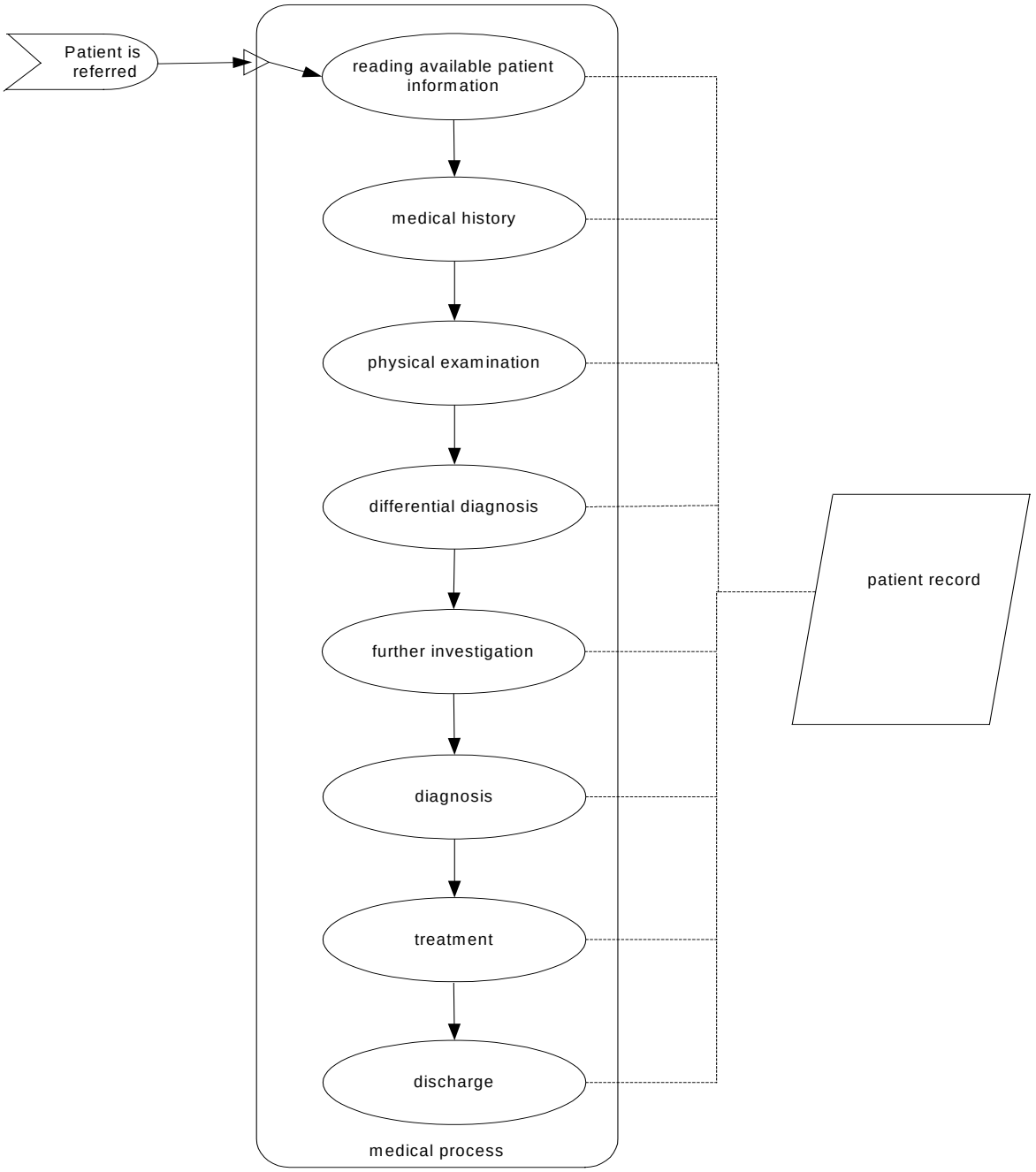

Figure 6. The medical process.
In this model elements of the Testbed modeling tool are used (*Testbed*). The process starts with the trigger 'patient is referred'. The rounded rectangle represents 'behavior' consisting of actions, represented by ellipses. The dotted lines represent manipulating data by reading and writing in the patient record, which is represented by a parallelogram (meaning data). The model is based on the author's training as a physician.
Explanation of the medical process: apart from some smaller specialties and emergency, patients have to be referred by a GP or other physician before they can visit a medical specialist. Reading available information comprises reading the referral letter, previous discharge letters, test-results and so on. The differential diagnosis is the conclusion drawn by the physician and consists of a ranked list of possible diseases or explanations of the patient's state. Further investigations can involve lab test, pathology, radiology, microbiology, etc. When treatment has finished a medical specialist writes a discharge letter to the referring physician and a copy to himself, which serves as a summary of the patient. See also figure 7 for the patient record.

The patient record plays an important role during the medical process. Findings are documented and later retrieved to decide about the patient. Tang and McDonald (2001) describe four kinds of information physicians record:

1. Patient histories.
2. Physician's findings from the physical examination.
3. Physician's interpretation of the patient's findings.
4. Physician's diagnostic and treatment plans.

Figure 7 shows the typical structure of a patient record used by physicians. Each phase of the medical process (figure 6) uses different sections of the record. Especially at the start of the medical process and during construction of a differential diagnosis or deciding about the final diagnosis, information of all sections is used.

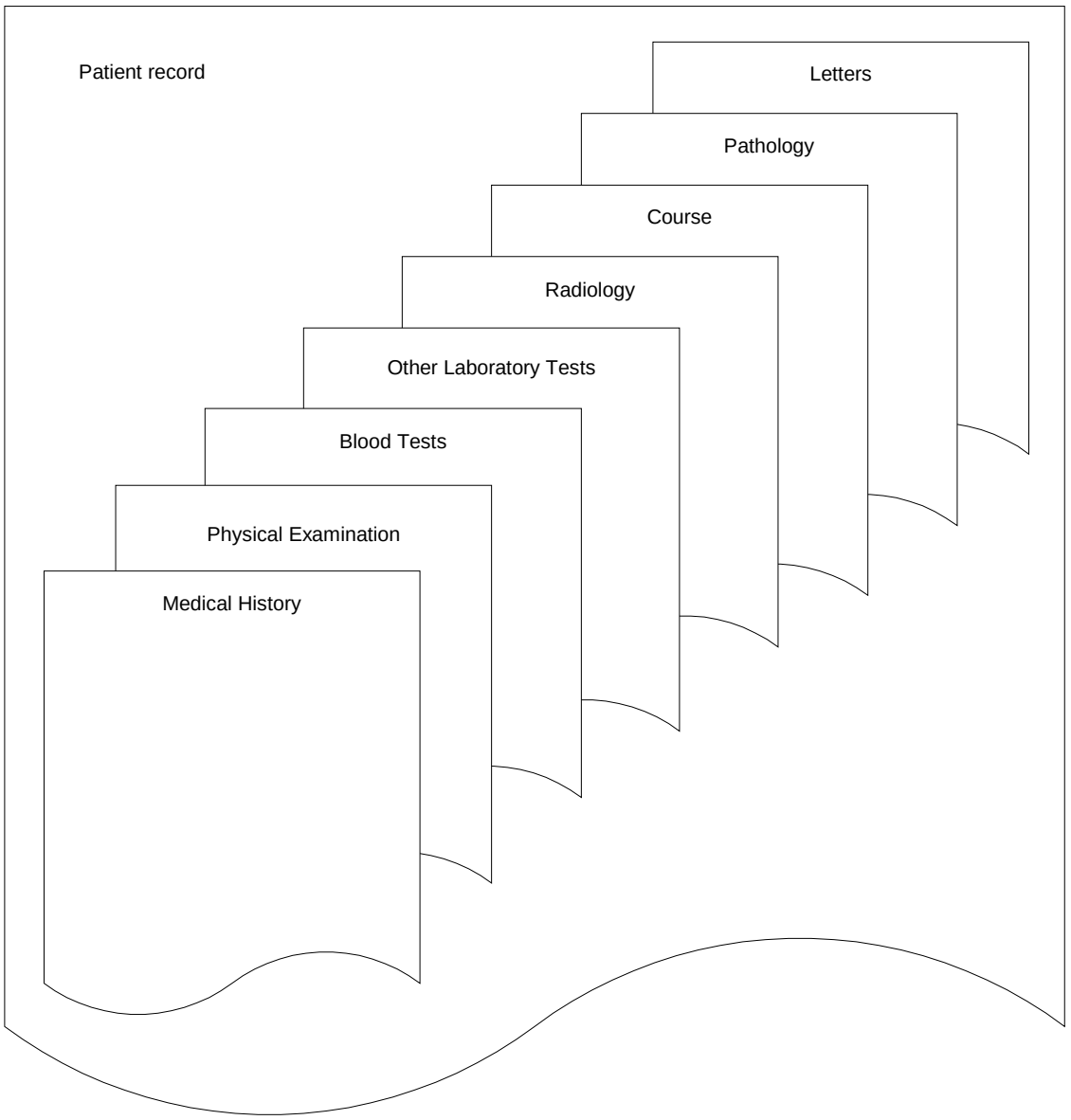

Figure 7. Typical structure of the patient medical record.

The primary structure of the patient record is source-oriented; each discipline has its own patient record and in each record lab-results, pathology reports, letters, etc. are stored in different sections. Apart from the initial medical history and the physical examination, all free text components, like the (differential) diagnosis and treatment plan are usually entered in the section 'course'. Within each section the order is usually chronological. The model is based on the author's training as a physician.

Care process

The medical process is part of the whole care process. Physicians have a central position in the care process (Michel-Verkerke et al., 2003a; Michel-Verkerke et al., 2003c). Only they have the authority to decide on hospital admission and discharge, referrals, medical treatment, to request tests and images and to prescribe medication and order surgery. Paramedical care providers such as physiotherapists; speech therapists and nurses depend on physicians, but also laboratories and radiology (see figure 8).

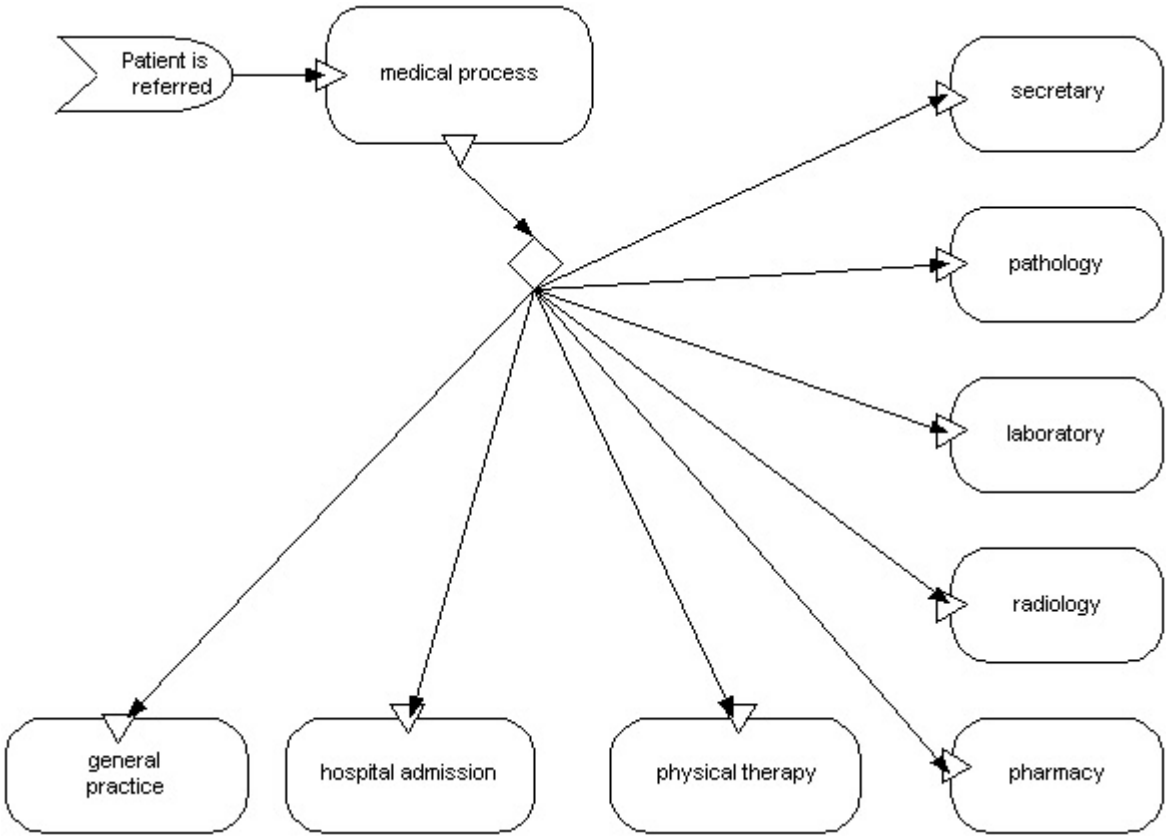

Figure 8. The medical process as part of the care process.
In this model elements of the Testbed modeling tool are used (*Testbed*). The process starts with the trigger 'patient is referred'. The rounded rectangles represent 'behavior' or processes. The open rhomb represents an 'or-split', which means that one or more of the following behaviors can happen. The behavior-blocks on the right and below show the many processes that are initiated by the medical process. For many of these behaviors the medical process is an 'enabling' trigger, without which the process will not start. The model is based on the author's training as a physician and researches on health care chains (Michel-Verkerke et al., 2003a; Michel-Verkerke et al., 2003c).

The dependency of medical specialists of others within the hospital organization is much more indirect. Medical specialists need the supporting services of secretaries, paramedical assistants and nurses, but physicians do not need their permission to perform their tasks, as is the situation with paramedics depending on physicians. This central position of the physician in the medical process is also reflected in the information process: physicians have to supply essential information like diagnoses, requested tests and prescriptions and they also have to authorize information, like test results before they become 'official'.

3.3. Problems medical specialists face

In the previous sections the physician and his work are described. In this section some problems medical specialists face are presented in order to be able to establish the relevance of advantages and disadvantages of paper and electronic patient records.

The Nivel institute (for quality of care) performed a research among medical specialists and asked them whether situations occurred where they were not able to deliver care according to their professional standards. Over 70% of the 255 responding specialists replied that during the 12 months before the investigation often or at regular intervals these situations occurred. The three most frequently reported problems were:

- Not being able to spend enough time on a patient during a consult (patient-encounter in outpatient clinic),
- Not being able to have a patient surgery, at the moment and in the hospital the specialist considers necessary, and
- Not being able to admit a patient to hospital, at the moment and in the hospital the specialist considers necessary.

According to the interviewed specialists these situations were mainly caused by the shortage of staff; other related causes are shortage of hospital-beds and shortage of money (Beaujean et al., 2002).

Another problem that health care providers in many countries face are the increasing complexity of medical problems due to the ageing population; more time, skills and knowledge is needed per patient. Also the increase of medical knowledge makes it impossible for physicians to know ‘all’ and raises the need for ‘accessible’ knowledge.

When looking at the information needs of physicians the problem of inadequate patient data exists, due to:

- ‘Lost’ (paper) patient records,
- Lacking information exchange, and
- The lack of an overview: it is not known what patient data exist.

Lack of relevance

From their research on the failing implementation of an Electronic Prescription System for general practitioners Schuring and Spil (2003) concluded that resistance resulted from the lack of relevance. This seems consistent with the findings of Metzger and Teich (1995), who state: "In many cases, physician use of clinical functions is voluntary and, unless they conclude that the system is a reasonable tool, they simply will not use it." and with Van Ginneken and Moorman (1997) “The greatest challenge is the tension between effort and benefit. It should be kept in mind that users will invest in the quality of their patient records only if it is rewarding.”

3.4. Conclusion

The physician can be characterized as a medical professional, who plays a central role in the care process and who treasures his professional autonomy. Being a professional a physician makes the decision to adopt an innovation by him self. The main argument to adopt will be relevance, i.e. will the innovation solve his problems? These problems are shortage of time, staff and money, and inadequate patient data, resulting in the incapability to provide the desired quality of care. Resistance of physicians to information systems is probably equal to other groups of professionals.

The medical process is a complex, non-routine and information-intensive job. A lot of communication and information exchange with other care providers and staff in hospital is part of the medical process.

With this information the table of factors that enhance user satisfaction (table 3) can be made more concrete, executing the second phase in the construction of the conceptual model. Table 4 shows the result.
To accomplish a high *relevance* the problems mentioned in section 3.3 must be solved. Saving time of the physician enables him to spend more time on his patients. Saving time and money in the hospital organization may contribute to solve the problem of short capacity of hospital-beds and surgery.

Factors that enhance user satisfaction	**Must be:**	**IS-requirements following from user characteristics**
Relevance	*High*	Problems are solved
Perceived usefulness	High	Showing coherent patient information Support in dealing with complex medical problems Support of information exchange (communication) Access to medical knowledge
Relative advantage	High	Save time of physicians, so that more time can be spend on patients Save time of other staff, so that the hospital capacity effectively increases Save money
Net benefits	High	
Compatibility	High	Flexible: compatible with the individual working process of each physician
Requirements	*Met*	
Ease of use	High	Easy data entry Easy data retrieval
Information quality	High	Information must be correct, complete, available in time
System quality*	High	No downtime during the medical process
Resistance	*Low*	Respect professional autonomy: no interference with medical decision-making Relevance must be high Needed effort must be low
Complexity	Low	
Trialability	High	
Observability	High	
Resources	*Sufficient*	Minimal use of resources, especially time of users
Service quality	High	

Table 4. User characteristics added to the IS-success factors.
* System quality is also an element of the resources.

Supporting communication helps to solve the problem of insufficient patient data. Making medical knowledge accessible during the working process helps to deal with the fast increase of medical knowledge.

As is described in section 3.2. the medical process is based on a general pattern, but evolves in many different ways, depending on the patient and the physician. That is why the system must be compatible with the different ways physicians work.
One of the *requirements* that must be met to overcome the resistance described by Dick et al. (1997) and Van Ginneken and Moorman (1997) in section 3.1, is easy data entry. The scheduling of consulting hours is usually very narrow; this means that downtime is not tolerated during these hours. The requirements concerning information quality and retrieval should solve the problem of insufficient patient data. The interface-requirement follows from the need for compatibility and the shortage of time a physician experiences.
To prevent *resistance* the professional autonomy of the physician must be respected. Little can be said on the influence of complexity, trialability and observability on the resistance of physicians.

4. What product characteristics of the EPR determine user satisfaction, when the physician is the user?

"What features and functions of computer systems are currently acceptable for clinical use, and what improvements are needed to increase the value of these systems?" (Drazen et al., 1995), p.48).
"In many cases, physician use of clinical functions is voluntary and, unless they conclude that the system is a reasonable tool, they simply will not use it." (Metzger and Teich, 1995)
"According to the Institute of Medicine study, "perhaps the single greatest challenge that has consistently confronted every clinical system developer is to engage clinicians in direct entry." "Physicians consider retrieval and entry as separate tasks, benefits in terms of saved time by using the computer should be clear for each task (Metzger and Teich, 1995).

The challenge of this chapter is phrased by the above cited authors and worded in research question 2:

What product characteristics of the EPR determine user satisfaction, when the physician is the end-user?

a. *What is an Electronic Patient Record? Functions, purposes, users.*
b. *Will there be a common (shared) or generic set of characteristics or requirements the EPR has to meet?*
c. *Is it possible to design an EPR that satisfies all user requirements (one size fits all) or that can be adjusted to all requirements of different user groups?*

Positioned in the USE IT-model this chapter deals with the product-determinants relevance and requirements. The findings about relevance of the previous chapter will be made more concrete in this chapter.

Based on the description of the medical process in section 3.2 the functions an EPR could or should have are discussed from the physician's point of view. Next a comparison will be made between the paper and the electronic record in order to reveal the attributed value of an Electronic Patient Record. Finally the requirements for an EPR and the relevance of an EPR and its functions to physicians are described. From this a list of EPR-characteristics will be derived that should determine user satisfaction of physicians. This list will be used to construct the conceptual model (chapter 5).

4.1. Purpose of medical record keeping

The purpose of medical record keeping has evolved during time. As far as physicians kept records, at the end of the nineteenth century it was to support their own memory. These records were not patient-oriented, but a chronological account of events in a hospital ward. At the beginning of the twentieth century hospitals in the United States became centers of medical care. In the same time the medical profession gained its professional status and the attached autonomy. Medicine became a science that needed documentation of care processes to analyze. The medical records became patient-oriented and were purposed to develop scientific knowledge. To warrant a certain level of quality a need of standardization of medical procedures and terms arose and a need of quality accounting. In the Netherlands the influence of the hospitals on physicians was not as strong as in the U.S.. Physicians were requested to keep a minimum set of patient data in records, but were not imposed to do so. The records were stored in central archives, which caused the hospitals to leave the concept of a hospital being a collection of buildings in a park, and move to one large building with a central storage-room for patient records.

Dutch physicians resented interference of the hospital management with the structure and content of the medical records (Berg et al., 1998).

As is shown in figure 7 the structure of the present typical paper patient records in a Dutch in- and outpatient clinic is a combination of a source-oriented and a chronological oriented medical record. Problem lists are seldom used. Every specialty and discipline[8] keeps its own record.

Tange (1997) asked 85 specialists and residents of an academic teaching hospital, for what functions they used the (paper) medical record and what functions they considered useful.

Function	**Frequency of use**	**Importance**
Memory support	Daily	High
Communication tool	Daily	High
Planning of activities	Daily	High
Administration	Less than weekly	Less
Quality accounting	Less than weekly / weekly / daily	High
Patient case discussion	Less than weekly / weekly	High
Research	Less than weekly	High
Medical education	Less than weekly	Less

Table 5: Frequency of use and considered importance based on Tange (1997).
The frequency that is reported most is listed. For quality accounting all frequencies were reported. High importance means that 63-85% reported the function as important, less important corresponds with 37% or 38% positive responses.

4.2. Purposes and functions of an EPR

An EPR can - like all information systems - be described from different perspectives and at different abstraction levels. In this research the EPR will be described at the application level of the OSI reference model[9] from the medical specialist's perspective (see previous and next chapter). The end-user is defined as the person who uses the information the system produces and operates the system manually, or communicates directly with the system (Woodroof and Kasper, 1998). This means that the technical implementation will be considered as a black box.

Probably one of the first articles published on the use of computers to keep medical records, is written by Weed in 1968. He considers the development of "a more organized approach to the medical record, a more rational acceptance and use of paramedical personnel and a more positive attitude about the computer in medicine" as a necessity to achieve the "routine completeness, expected of physicians in the history and physical examination". Since "thoroughness and order in the whole process decrease drastically and indiscriminately as work pressures build up", it is necessary to take measures that guarantee the completeness of the record from the beginning. These measures comprise the use of properly trained

[8] A specialty represents a specific field of medicine, like surgery, internal medicine, dermatology, radiology and pathology. A discipline represents a profession, like nurses, physicians, physical therapists, speech therapists, etc.
[9] The Open Systems Interconnection reference model of the International Standards Organization consists of seven layers. The application level is the highest layer, the physical level the lowest.

nurses to perform routine interviews and examinations, the storage of these patient data in a computer record and the introduction of the problem-oriented medical record (POMR) (Weed, 1968a; b).
The problem-oriented medical record has a problem-list on the front consisting of two columns: one listing the active problems of the patient and the other listing the resolved problems. The physicians do not interact with the computer, but use prints of the patient record. The collected patient data should be analyzed in order to let the physician "act as a scientist", when solving the patient's problems. The POMR-concept is adopted by Dick (et al., 1997), and is partially adopted by Dutch general practitioners. For the recording of each patient encounter the “SOAP-structure” is used, which stands for Subjective (the complaints as phrased by the patient), Objective (the findings of the physician), Assessment (the test results and conclusions, such as a diagnosis) and Plan (the treatment or policy). In Dutch GP information systems a summarizing problem-list is not composed.

Collen published a second influential article in 1970. In this article he defines a medical information system (MIS) as "one that utilizes electronic data processing and communications equipment to provide on-line processing with real time responses for patient data within one or more general medical centers, including both hospitals and outpatient services". Collen considers a hospital information system (HIS), a laboratory data system and a hospital administrative information system as subcomponents of an MIS. The objectives of an MIS, according to Collen (1970) are listed in table 6 (see appendix A for the complete table).

Objectives of an MIS
• Communicate patient data to other professionals, and to hospital services
• Communicate information for scheduling
• Establish a medical database that has a high utility for medical services for the individual patient and physician.
• Fulfill research objectives.
• Business and administrative functions
• Improve the cost and quality of medical services

Table 6. Objectives of a Medical Information System based on (Collen, 1970).

Table 6 shows that in Collen's opinion an MIS is an all-comprising computer system that stores and communicates patient data in order to improve the medical care process and the administrative process and research. A strong desire for information can be recognized from the listed objectives. Compared to Weed (1968a) Collen does not just want to improve the quality of medical care, but also adds communication and support of administrative and logistic processes in the hospital.

The report of the Committee on Improving the Patient Record of the Institute of Medicine (published in 1991) brings order in these many purposes by distinguishing two levels of uses of patient records: primary and secondary uses (Dick et al., 1997)[10]. The primary uses "are associated with the provision of patient care, that is, with providing, consuming, managing, reviewing, supporting, and charging and reimbursing patient care services”. Secondary uses of patient records are not considered necessary for a particular encounter between a patient

[10] The second edition of the report published in 1997 consists of an unaltered reprint of the first edition of the report published in 1991 and some additional chapters. Reference to Dick et al. 1997, refers to the reprint of the original report.

and a health care professional, but such uses influence the environment in which patient care is provided. Education, research and development, regulation, and policymaking are all considered secondary uses of the patient record." When looking at the complete list of primary uses in table A7, appendix A, one can doubt whether all these uses should be marked as “primary uses”. Looking from a physician’s perspective only elements in the section labeled “Patient Care Delivery (Provider)” are primary. These are listed in table 7.

Primary uses of patient records
Patient Care Delivery (Provider) • Foster continuity of care (i.e. serve as a communication tool) • Describe disease and causes (i.e. support diagnostic work) • Support decision making about diagnosis and treatment of patients • Assess and manage risk for individual patients • Facilitate care in accordance with clinical practice guidelines • Document patient risk factors • Assess and document patient expectations and patient satisfaction • Generate care plans • Determine preventive advice or health maintenance information • Remind clinicians (e.g., screens, age-related reminders) • Document services provided (e.g., drugs, therapies)

Table 7. Primary uses of the patient record from a physician’s perspective. Based on Box 2-2A (Dick et al., 1997)

According to Rector and Nolan (1991) the "principal purpose of the medical record is to support individual patient care". This is confirmed by Van Ginneken and Moorman (1997). However, developments in health care caused a greater demand for patient data for purposes other than patient care (see table A7a appendix A). Their list does not expand the primary and secondary uses listed by Dick (et al., 1997), but shows fewer items. This shows that the ideal of one all comprising medical information system is replaced by development of different information systems for different purposes.
Although Tang and McDonald (2001) state that a computer-based patient record is designed to overcome logistical, organizational, and other practical limitations, which reduce the effectiveness of traditional records for storing and organizing an ever-increasing number of diverse data, they only focus on primary uses of the EPR.

Functional Components of an Electronic Patient-Record System
Integrated view of patient data
Clinical decision support
Clinician order entry
Access to knowledge resources
Integrated communication support

Table 8 based on (Tang and McDonald, 2001)

In their view an EPR can provide additional benefits that cannot be attained by a static view of events as in a paper record. Table 8 shows the functional components of an EPR according to Tang and McDonald (2001). A new component in this list is the function for clinician order entry.

Conclusion

From these publications can be seen that the purpose of record keeping has shifted from a way to keep memory of care provided to improving of science to improving of quality of care and accounting of this quality towards the patient. Technological developments changed the ideal of one all-comprising information system towards a network of smaller systems and from archiving towards communication and active task support, and from hospital level to individual patient's and physician's level.

Integration of the listed functions of the before mentioned sources, results in the list of functions in table 9.

Functions of the Electronic Patient Record	**Reference**
• Describe disease and causes	(Dick et al., 1997)
• Clinical decision making support	(Dick et al., 1997; Van Ginneken and Moorman, 1997; Tang and McDonald, 2001)
• Access to medical knowledge bases	(Tang and McDonald, 2001)
• Integrated view of patient data	(Tang and McDonald, 2001)
• Anticipation of future health problems	(Dick et al., 1997)
• Generate care plans	(Dick et al., 1997)
• Document care provided	(Dick et al., 1997)
• Quality accounting	(Van Ginneken and Moorman, 1997)
• Clinician order entry	(Tang and McDonald, 2001)
• Communication support	(Collen, 1970; Dick et al., 1997; Tang and McDonald, 2001)
• Remind clinicians	(Dick et al., 1997)

Table 9. Functions of the Electronic Patient Record
Result of the literature study on this topic.

Now that the purpose of the electronic patient record is established, the next section will discuss why a paper record fails in serving these purposes.

4.3. The paper and electronic record compared

Dick (et al., 1997) name five strengths and four weaknesses of the paper record from the perspective of the record users (see table 10). Tange (1997) investigated the satisfaction of physicians with paper records in a teaching hospital and compared his findings with the statements of (Dick et al., 1997). The physicians in Tange's research (1997) proved to be more positive about the paper record than is expressed by Dick (et al., 1997), in respect to completeness of data on diagnostic and therapeutic interventions, reliability and timeliness of the data, and the ease of retrieving of own data. This more positive attitude does not mean the physicians were completely satisfied with the paper record. They agreed with the

Committee on Improving the Patient Record that the completeness of decisions, orders and plans made, and the ease and speed of data retrieval needed improvement.

Strengths of the paper record	Weaknesses of the paper record
• Familiar to users • Portability • No downtime • Flexibility in recording data • Easy to browse and scan	• Content • Format • Access, availability, and retrieval • Linkages and integration

Table 10. Strengths and weaknesses of paper patient records (Dick et al., 1997).

As an additional advantage of the paper record Van Ginneken and Moorman (1997) put forward that no special training is required. They also name two disadvantages that are not mentioned by the previous authors: For scientific analysis, the contents need to be transcribed, which can cause errors, another disadvantage is that the paper records cannot give rise to active reminders, warnings, or advice.

When looking at these advantages and disadvantages of the paper patient record it is interesting to know to what extent these opinions can be explained by the extent to which the paper record can fulfill its purposes. Table 11 shows what desired functions of the electronic patient records the paper record can fulfill.

Functions of the Electronic Patient Record	Can be fulfilled by paper
• Describe disease and causes	Yes
• Clinical decision making support	No
• Access to medical knowledge bases	No
• Integrated view of patient data	No
• Anticipation of future health problems	No
• Generate care plans	Only passive and very limited: Forms can be offered
• Document care provided	Yes
• Quality accounting	No
• Clinician order entry	Only passive: Forms can be offered
• Communication support	Only passive and very limited: by written orders, location of the record
• Remind clinicians	Only passive and very limited, e.g., by writing allergies in red on the cover.

Table 11. Can the paper-based record fulfill the functions of the Electronic Patient Record?

From this the conclusion follows that a paper patient record serves as an easy way to document the patient's history and the care provided, but fails on the other functions. The

electronic record is much better capable of fulfilling its functions in the medical process and also has some additional advantages, see table 12.

Advantages of Electronic Patient Records	
Van Ginneken and Moorman (1997) • Simultaneous access for multiple locations • Legibility • Variety of views on data • Support of structured data entry (SDE) • Decision support • Support of data analysis • Electronic data exchange and sharing care support	Tang and McDonald (2001) • Flexible • Adaptable • Data can be used in different ways • Data can be used by different users • Better organized by imposed structure • Validity checks possible • Reusability of data • Users are stimulated to accurate data entry

Table 12 The advantages of EPR's based on Van Ginneken and Moorman (1997) and Tang and McDonald (2001).

Although the advantages of a computer-based patient record opposed to the disadvantages of a traditional patient record are clear to Tang and McDonald (2001), they also see disadvantages of the computer record. See table 13.

Disadvantages of Electronic Patient Records
• Large investment needed • Personnel is away for training • Work processes need change • Interaction with the patient may need change • Downtime • Physicians may resist direct data entry

Table 13 The disadvantages of Electronic Patient Records (Tang and McDonald, 2001)

Comparison of satisfaction with a patient care information system between nurses and physicians revealed that both groups were in general more satisfied with the electronic system than with the paper record (Drazen, 1995). Physicians were more satisfied in situations where they had no supporting staff to find lacking information for them, than in situations where nurses would perform this task. Nurses were more satisfied with the electronic system than with the paper record, when the electronic system relieved them of the task of seeking missing patient information. These results show that the availability of data is the main advantage of the EPR, but also that satisfaction with an electronic patient record is greater when the benefits are directly experienced. This research also shows that physicians requirements differ from those of other user groups (Drazen, 1995).

Conclusion

The main advantages of the paper-based record are that it is easy to write in, can be taken to the patient and the physician is used to it. But its main advantage, i.e. its portability, is also its main shortcoming: the paper record is a single hardcopy that easily gets lost or simply is not at the place where it is needed and, by that not able to yield its content. Other disadvantages of the paper-based record are the inaccessibility of its content, due to illegible handwriting, unstructured text, and source- and time-oriented structure.
The main advantage of the Electronic Patient Record is that it can overcome all failures of the paper-based record and offers additional functions, like decision support, order entry, active alerts and access to knowledge bases. Unfortunately there is a price to pay. When the hurdle of investing money and training-time has overcome, data entry in a computer by physicians will remain harder than writing in a paper record.

4.4. Requirements for the Electronic Patient Record

What requirements have to be met to realize the proposed improvements in such a way that physicians will use the system? The main requirement is formulated by Tang and Hammond (1997): “key to gaining clinician user acceptance is providing efficient tools that help clinicians retrieve and understand data relevant to their decision-making tasks.” Phrased in another way, one could say that the system must be relevant to the physician.

The Committee on Improving the Patient Record gives an extensive list of user requirements, a selection is made for the medical specialist see table 14 (Dick et al., 1997).

User requirements for patient record systems	
Information on outcomes of care and functional status	Linkages with other information systems (e.g., radiology, laboratory)
“Front-page” problem list	Linkages with relevant scientific literature
Ability to “flip through the record”	Linkages with other institutional databases and registries
Integrated among disciplines and sites of care	Linkages with records of family members
Rapid retrieval	Standard clinical reports (e.g., discharge summary)
24-hour access	Customized reports
Available at convenient places	Trend reports and graphics
Easy data input	Safeguard against violation of confidentiality
Decision support	Minimal training required for system use
Clinician reminders	
Customization	

Table 14. User requirements for patient record systems (Dick et al., 1997).

Metzger and Teich (1995) looked at Electronic Patient Records from a functional perspective and formulated six design prerequisites (see table 15, a more extensive description is given in appendix A). The last three prerequisites fit with the emphasis of Tang and Hammond (1997) lay on the importance of effective user-computer interfaces, but Metzger and Teich (1995) do not think an effective interface is enough to persuade physicians. They consider extra incentives like immediate tangible benefits necessary.

Design Prerequisites for Electronic Patient Records
The systems must: • Be available whenever users need them to manage patient care. • Be available wherever decisions about care are made. • Provide quick and value-added access to information. • Fit actual patient care processes and work situations. • Be so easy to use that little or no training is required. • Involve physicians with direct entry.

Table 15. Design prerequisites for Patient Care Information Systems (Metzger and Teich, 1995)

What information is presented and how, must fit to the cognitive processes of the user. To accomplish this fit Patel and Kushniruk (1997) list additional requirements for the EPR from the perspective of Human Computer Interaction (table 16).

Requirements for the successful development of human computer interfaces in health care	
• Effectiveness	• Input flexibility
• Ease of understanding	• Appropriate amount of output
• Predictability	• Adequate user help and error recovery
• User control	• Adequate response times
• Robustness	

Table 16. The requirements for human computer interfaces in health care.
Effectiveness: the system should do what is functionally required; Ease of understanding: users should be able to develop a coherent model of the system that will allow them to use the system accurately and effectively; Appropriate amount of output: the system should not overwhelm the user with large amounts of data that lead to cognitive overload (Patel and Kushniruk, 1997).

The different focuses chosen by the authors become evident when comparing the lists of requirements. Dick (et al., 1997) not only looks from the care provider's perspective, but also from secondary users and from a 'control and management'- perspective. He also demands the use of standard terminology. Metzger and Teich (1995) on the other hand see the use of familiar terminology and the allowance of synonyms as a prerequisite to persuade physicians to enter data. The by Dick (et al., 1997) required "front-page problem list" reflects the preference for the problem oriented medical record as proposed by Weed (1968a). Metzger and Teich (1995) disagree with Dick on this point and state that an EPR should allow all possible patient approaches and customized views on the patient data. Both agree on the demands on availability of all relevant patient data and the minimal training. A requirement not mentioned is the compliance with legislation.

Conclusion

From the requirements listed by the previous discussed authors those requirements that relate to the physician as an end-user in the primary process are combined and summarized in table 17.

Summary of EPR requirements	
Easy, quick and value-added data retrieval	(Metzger and Teich, 1995; Tang and Hammond, 1997; Tang and McDonald, 2001)
Easy flexible data entry	(Dick et al., 1997)
Access anywhere	(Metzger and Teich, 1995; Van Ginneken and Moorman, 1997)
Access anytime (No downtime)	(Metzger and Teich, 1995)
All relevant patient data available in a integrated way	(Dick et al., 1997)
Communication support	(Dick et al., 1997)
Decision support	(Dick et al., 1997; Van Ginneken and Moorman, 1997)
Clinician reminders	(Dick et al., 1997)
Customization, user control	(Metzger and Teich, 1995; Patel and Kushniruk, 1997)
Easy reporting	(Dick et al., 1997)
Privacy protection	(Dick et al., 1997)
Minimal training	(Metzger and Teich, 1995; Dick et al., 1997)
Fit actual care process and work situations and cognitive process	(Metzger and Teich, 1995; Tang and Hammond, 1997)
Maximum incentive for use by immediate tangible benefits	(Metzger and Teich, 1995)
Robustness	(Patel and Kushniruk, 1997)
Adequate user support	(Patel and Kushniruk, 1997)
Linkage to scientific literature	(Dick et al., 1997)

Table 17 Summary of EPR-requirements from the physician's perspective.

4.5. Relevance of the Electronic Patient Record

In the previous section the requirements are discussed from a functional perspective. When these requirements are met one can expect that the system will function to serve its primary purpose, i.e. supporting patient care. But meeting the requirements does not automatically imply that the EPR is relevant for the medical specialist. Relevance is defined in section 2.2. as solving the user's problems or helping to realize the user's goals. The goals and problems of the medical specialist are described in section 3.3. and concern shortage of time, too little surgery-capacity and shortage of hospital beds, the latter two mainly due to shortage of staff and money. Also the growing complexity of care and insufficient patient data are considered to be a problem.

To be relevant the Electronic Patient Record should help to solve these problems. Handling patient data is the strength of the EPR and this problem will be solved by the implementation of an EPR. Also the problem of complexity of care can be reduced by the EPR by supplying

decision support tools and knowledge bases. The other problems are less easy to solve by the EPR and can even be enlarged. A medical specialist has to invest time in learning to work with the system and data entry in the computer will probably continue to cost more time than writing in the paper record. An EPR largely abandons the time needed for searching paper records or test-results and so on, but this does not benefit the medical specialist directly, because he usually delegates these tasks to secretarial or nursing staff. In an indirect way the EPR helps solve the problem of shortage of staff, because this staff does not have to waste its time collecting and searching for records and writing down orders of the medical specialists in the records. The time benefit a physician could experience is in correspondence and filling out forms. On the short term the shortage of money will only be enlarged by the implementation of the Electronic Patient Record, because investments are needed. On the long term the EPR could bring financial benefit by making the care process more efficient and productive, i.e. more patients can be treated in less time.

4.6. Conclusion

The principal purpose of the medical record is to support individual patient care. To serve this purpose the record must be able to contain and show all relevant patient data in a way that fits with the way physicians perform their tasks. Due to the growing complexity of the medical process, physicians want active task support by alerts, decision support systems and easy accessible knowledge bases. Planning and communication must also be supported.
Although the paper record is familiar to physicians and entering data is easy, it cannot meet the requirements of medical record keeping to date. The Electronic Patient Record can, provided that the problem of data entry by physicians is solved.
The EPR-requirements listed in table 17 follow from the study of the product-determinants: relevance and requirements. When these requirements are compared with the IS-requirements, based on the study of the user-domain in the previous chapter, it can be seen that the EPR-requirements are more specific, but match with the IS-requirements (table 18). Only the requirements on the resistance determinant differ. The IS-requirement “respect professional autonomy” is not encountered in the discussed literature on the product. On the contrary: decision support and clinician reminders are named; both elements have the potential of ‘dictating’ the physician how to act and by that interfere with his professional autonomy. The demand for immediate tangible benefits is added.

Factors that enhance user satisfaction	**Must be:**	**IS/EPR-requirements following from the user domain**	**EPR-requirements following from the product-perspective****
Relevance	*High*	Problems are solved	
Perceived usefulness	High	Showing coherent patient information Support in dealing with complex medical problems Support of information exchange (communication) Access to medical knowledge	Value-added data Access anywhere Access anytime All relevant patient data available in a integrated way Communication support Decision support Clinician reminders Linkage to scientific literature

Relative advantage	High	Save money Save time of physicians, so that more time can be spend on patients Save time of other staff, so that the hospital capacity effectively increases	Easy reporting
Net benefits	High		
Compatibility	High	Flexible: compatible with the individual working process of each physician	Customization, user control Fit actual care process and work situations and cognitive process
Requirements	*Met*		
Ease of use	High	Easy data entry Easy data retrieval	Easy flexible data entry Easy, quick data retrieval
Information quality	High	Information must be correct, complete, available in time	Complete, correct data Robustness
System quality*	High	No downtime during the medical process	No downtime (Patient's) Privacy protection
Resistance	*Low*	Respect professional autonomy: no interference with medical decision-making Relevance must be high Needed effort must be low	
Complexity	Low		
Trialability	High		
Observability	High		Immediate tangible benefits
Resources	*Sufficient*	Minimal use of resources, especially time of users	Minimal training
Service quality	High		Adequate user support

Table 18. Factors causing user satisfaction translated to EPR-requirements.
** The ordering of EPR-requirements is arbitrary, because many EPR-requirements fit to more than one success-factor. The presented order is chosen to show that all success-factors can be translated to an EPR-requirement.

The principle requirements for an EPR seem to be general for all physicians. However, to fit the working processes of different specialties, it must allow multiple views on the patient data and specialty-specific interfaces. According to Van Ginneken and Moorman (1997) "there may be different specialties in a given clinic, each with its own requirements for the contents of the patient record. It is unlikely that one computer-based patient record could satisfy the majority of specialists. System developers must tailor the computer-based patient record for a specialist in such a way that the record can accommodate a variety of domains, while the record's contents can be merged with those of other providers to form a complete record of the patient's medical history."

The construction of table 18 is the third step in constructing the conceptual model. In the next chapter the fourth construction step will be made, by combining the results of the previously discussed literature.

5. The conceptual model and case study methods

In this chapter the results of the literature study – the conceptual model and the case study-methods – are discussed. In the first section the conceptual model will be completed, the second and third section deal with the questionnaire, which is developed for this research and the USE IT interview-protocol, which is adjusted for this research.

5.1. Conceptual model: physician's EPR-requirements

The conceptual model presented in this chapter is the first result of the literature study. The model is the answer to research question 4.:

In what way do the found product characteristics relate to the found user characteristics? (Construction of the conceptual model)

The conclusions of chapters 2, 3 and 4 are combined to a conceptual model that shows the relation between the user characteristics of the physicians and the product characteristics of the EPR necessary for a successful EPR-implementation. The purpose of the conceptual model is to explain the success or failure of the implementation of an EPR as far as this success or failure depends on the product and user characteristics. Whether the conceptual model is correct and is able to explain the results of an EPR-implementation will be tested in the case study (chapter 6).
Table 18 of chapter 4 shows the factors that enhance user satisfaction, the IS/EPR-requirements that follow from the user domain and the EPR-requirements that follow from the product characteristics. Since many requirements cannot be linked with just one success-factor, the success-factors in the conceptual model are grouped per USE IT-determinant (table 19.). The second column of table 19 shows the EPR-requirements that follow from the first column (chapter 4) and by that the requirements of physicians for the EPR.

REQUIREMENTS OF PHYSICIANS FOR THE ELECTRONIC PATIENT RECORD	
User demands	**Translated to EPR requirements**
Maximum relevance (Perceived usefulness, relative advantage, net benefits, compatibility)	Value-added data All relevant patient data is shown in a integrated way Access anywhere Access anytime Access to medical knowledge Decision support Clinician reminders Communication support Saving time Easy reporting Customization, user control Fit actual work process and cognitive process

Meeting requirements (Ease of use, information quality, system quality)	Privacy protection No downtime Complete, correct data Robustness Easy, flexible data entry Easy, quick retrieval
Causing minimum resistance	No interference with medical decision-making Immediate tangible benefits
Minimum use of resources (Service quality)	Minimal training Adequate user support

Table 19. The conceptual model: Requirements of physicians for the Electronic Patient Record.

Two case study methods are used to test the correctness of the conceptual model and to test whether the conceptual model can explain the success or failure of the EPR-implementation in the specific cases.

5.2. Interviews based on USE IT

The interview-protocol is based on the USE IT-model, as presented in section 2.3. The interview-protocol is used before and validated in the evaluation of an Electronic Prescription System (Lagendijk et al., 2001), the research on the Multiple Sclerosis health care chain (Michel-Verkerke et al., 2003c), the research on the Rheumatism Care Guide and in the TeleCare-project, concerning the care for stroke patients (Michel-Verkerke et al., 2003a). The main purpose of the USE IT-tool is to reveal the user characteristics of the physician in order to check the validity of the user demands as listed in the first column of the conceptual model. Especially the relevance of problems and solutions can be best established by interviews.

5.2.1. General remarks on the interview-protocol

The interview-protocol consists of open questions in six categories: process, requirements, relevance, resistance, resources and stake (see appendix B). An interview takes about 1,5 hour and is held in the interviewee's working room. After the interview a report is made and presented to the interviewee for corrections and additions. The interviews result in qualitative data. The order of the interview sections and questions is designed in such a way that the interviewee feels comfortable. First factual and "neutral" questions are asked to gain the trust of the interviewee. The interviewer does not show approval or disapproval towards the answers of the interviewee. The questions are also ordered and asked in such a way to prevent to give the interviewee the feeling that he has to have a problem or a certain opinion. This also means that the interviews are not suitable to check each EPR-requirement of the conceptual model; the value of the interviews is the finding of the user characteristics.

5.2.2. Interview-protocol per section

Process: Questions about the way the physician works, his place in the care process, with whom he communicates and cooperates and what exceptions and disturbances occur are the topic of this section. The answers give insight in the actual working process and are valuable to check the assumptions on the medical process, as formulated in section 3.2.

Requirements: To reveal the relevant requirements, the physician is asked what information he needs to perform his job and what information he produces. He is also asked about the use of the patient record.

Relevance: In this section the physician is encouraged to tell what he considers important and what is ranked high on his personal agenda. Also problems he faces and suggestions for improvements are asked for.

Resistance: This section comprises questions about the attitude towards ICT and questions about hindrances for the implementation of innovations in general.

Resources: Resources concern time, money, available ICT-facilities and the quality and availability of technical support.

Stake: The last question concerns the influence the physician has on adoption-decisions of the organization to check whether the hypotheses on his professional autonomy is true.

5.3. Questionnaire

The questionnaire is used to collect quantitative data on the satisfaction with the product characteristics in addition to the qualitative data on user characteristics of the interviews. Both sets of data are needed to be able to establish the relation between the both kinds of characteristics. Since filling out the questionnaire is less time-consuming than the interviews, more physicians can be interrogated with the questionnaire. In this section the construction of the questionnaire is justified. The used methodology is based on Babbie (1995) and Cooper and Schindler (1998). For legibility reasons no references to these two books are made in the following text.

5.3.1. General remarks on the construction of the questionnaire

The questionnaire measures the actual use of the EPR, user satisfaction and factors that influence the adoption-decision and consisted of the sections: used information systems and functions, purposes of the Electronic Patient Record, support of the medical task, ease of use, privacy (of the doctor), (adoption-) decision making. The questionnaire starts with explaining how the items should be scored (see Appendix C).
The questionnaire consists of open and closed questions. Two ways for responses on the closed questions are used: yes / no and a five-point Likert-scale. Questions concerning facts, like: “Do you use the electronic record for making appointments?” could be answer ed by circling Yes or No. Questions that concerned opinions, like: “The electronic record does contain all information I need.” could be answered on an ordinal measuring level by checking a box on a five-point Likert-scale, which corresponded with the answers: fully agree, partially agree, don’t know/ no opinion, partially disagree, fully disagree.
To reduce time for filling in the questionnaire the total number of items and especially the number of open questions is kept as little as possible. The closed questions are formulated in a positive way as far as possible. The items are only checked by opposite statements when relevant. The language used complies with the language, which is familiar to medical specialists. The ordering of items complies with the regular working process, as far as possible or relevant. The layout of the questionnaire leaves room for adding comments.
All items are intended to be one-dimensional, i.e. measuring one dimension. Where ambiguity could exist, multiple items are used to differentiate between different aspects. The time it takes to fill in the questionnaire is estimated on 10 – 20 minutes.

5.3.2. Questionnaire per section

The actual use

The physicians are asked what information systems they use in practice by listing the most frequently used systems. The purpose of this question was to know what systems are used, but also to make clear that in the questionnaire distinction is made between an EPR and other information systems. To indicate the information systems general terms were used with examples of well-known trademarks, e.g., “office automation (e.g., Word, Excel).” To measure the actual use of the Electronic Patient Record, first a list of general functions was given, followed by a list of functions matching the steps of the medical process. Room was given to add information systems or functions. One could answer yes or no. The frequency of use was not asked, because the assumption was made that physicians would use a function for all patients or not at all. To check this assumption the section ended with an open question whether a paper patient record was used and in what situation or for what function.

Purposes of the Electronic Patient Record

Twelve statements could be scored using a five-point Likert-scale (fully agree, partially agree, don’t know/ no opinion, partially disagree, fully disagree). The statements not only measure for what primary and secondary purposes the recorded patient data were used, but also what user groups used these data.

Support of the medical task

The measurement of user satisfaction is based on the research of Garrity and Sanders (1998). They asked a panel of experts to judge questionnaire items stemming from instruments to measure IS-success on their value in measuring IS-success and to classify them into four categories: task support satisfaction, quality of work life satisfaction, interface satisfaction and decision-making satisfaction. The resulting table shows questionnaire items of the instruments of Franz and Robey (1986), Doll and Tokzadeh (1988), Baroudi and Orlikowski (1988), Sanders (1984), Davis (1989) and Goodhue (1990). The items from this table are reformulated to fit the case situation of medical specialists using an EPR. Eighteen statements using a five-point Likert-scale (fully agree – fully disagree) measured the dimensions: time saving, quality of tasks, usefulness, appropriateness of information and system-functions, completeness of information and system-functions, redundancy of information and system-functions, and availability of information and system-functions.
Instead of adding statements about the satisfaction with specific functions, open questions were added at the end of the section about advantages and disadvantages of the electronic and paper record. Adding closed questions on the satisfaction with specific functions would make it necessary to add an extensive list to prevent “prompting” satisfaction on specific functions. This would make the questionnaire too long.

Ease of use

This section is based on the research of Garrity and Sanders (1998) concerning interface satisfaction. Seventeen statements using a five-point Likert-scale measured the dimensions ease of data retrieval, ease of data entry, compatibility with working process, ease of learning, ease of understanding and satisfaction with using mouse and keyboard.

Privacy (of the doctor)

The first of these five statements using a five-point Likert-scale measures the attitude towards sharing the patient record with others, which can be perceived as an infringement of the professional autonomy. The other four statements measure whether this attitude results in a change in behavior or not.

(Adoption-) Decision-making

The last nine items of the questionnaire measure whether and to what extent physicians are free to adopt or reject the use of an Electronic Patient Record. This freedom also gives an impression of the professional autonomy.

Unasked questions
No questions are asked on the technical performance, like toleration of downtime, robustness, completeness and correctness of the data, because these were considered to be obvious and not disputable requirements. These requirements were also implicit in questions about the availability of data. For the same reason nothing is asked about the confidentiality and patient's privacy. The privacy of patient data is protected by legislation; the requirements for the EPR on this topic follow from law.

5.4. Case selection

The purpose of the case study is to validate the conceptual model, which is based on assumptions on user characteristics of medical specialists in relation to product characteristics of EPR's. The case study should not only justify or falsify these assumptions, but also provide an alternative explanation in case of falsification, if possible.

For the case study medical specialists who actually use an EPR are asked for co-operation. They were only informed about the goal of the research, i.e. finding out why medical specialists actually use an EPR. The medical specialists did neither know the assumptions to be tested, nor the content of the conceptual model.

Six fellowships of medical specialists in five hospitals are approached either directly or via their IT-department. This method of case selection corresponds with a non-probability sampling method, i.e. judgment sampling, which is a form of purposive sampling (Babbie, 1995). Judgment sampling means that sample members are selected to conform to some criterion. In this case the criterion was the actual use of an EPR. This sampling method has consequences for the representativeness of the sample. Since the use of an EPR is not generally spread among medical specialists – which is the mean reason for conducting this study – it is likely that the selected medical specialists can considered to be early adopters (Rogers, 1995). This means that the interrogated medical specialists probably do not represent all Dutch medical specialists concerning their attitude to change, which is an element of resistance (see p.23). However, there is no reason to assume that the medical specialists participating in the study differ from their fellows in respect to the other user characteristics, but this is not checked.

Medical specialists of four fellowships of two hospitals agreed to cooperate in the research either by filling in the questionnaire or by being interviewed. All specialists of the two fellowships in hospital A used the same EPR. One of five cardiologists participated in the study, also five out of six internists and one out of three gastro-enterologists[11] (the internists and gastro-enterologists make one fellowship). In Hospital B a different EPR is implemented. Five specialists use the EPR entirely, of which two filled out the questionnaire – one internist and one cardiologist – and ten specialists use the EPR only partially. Because of the small numbers of participants representativeness of the results for all medical specialists of for members of the three specialties cannot be claimed. Nevertheless the participation of the internist-fellowship is very high (67%), and by that can be considered to be representative for this fellowship. As is stated before there is no reason to assume that this fellowship differs from other fellowships apart from their positive attitude to change.

The Electronic Patient Records used in both hospitals were at the time of the case study only meant for physicians' use, in hospital A nurse practitioners have access too. The EPR's could be used as complete medical record, replacing the paper record. The specialists can retrieve all patient data of their own specialty and letters of all specialties in the entire hospital.

[11] A gastro-enterologist treats disorders of the digestion organs, like stomach, bowel and liver.

The EPR's also served as a "viewing box" on the hospital information system (HIS): lab results, radiology and appointments could be retrieved. Data entry was only possible in the outpatient clinics.

6. Case study

The conceptual model will be evaluated by applying it to cases with known successful implementation of an EPR. The two case study tools presented in chapter 5 (USE IT-interviews and questionnaire) are used to perform the case study. First the results of the interviews are presented, followed by the results of the questionnaire.

6.1. Results of the USE IT interviews

The results of the USE IT interviews will first be described per section of the interview-protocol, followed by a conclusion.

6.1.1. Medical process

All three specialists work in the inpatient and outpatient clinic of the hospital. They all have a special interest and expertise within their medical specialty. The special interest of the cardiologist is disturbances of the cardiac rhythm; one internist is specialized in endocrinology[12] and the other in hematology and oncology[13]. Both internists cooperate with nurse practitioners. They are very satisfied about this cooperation. Patients are referred by general practitioners (GP's) and by fellow specialists. The specialists refer patients to academic hospitals or – most commonly – back to the GP.
In the outpatient clinic the EPR is used instead of a paper record. Patient data are entered and retrieved by the physician. The EPR does not have active elements, like decision support or medical alerts. A very appreciated function is the easy composing of letters and the access to all letters of most specialties. Paper records and letters from internists who do not use the EPR for data entry yet are scanned. The EPR also serves as a "viewing box" on the Hospital Information System (HIS), which shows the lab-results, appointments and X-ray-reports with images. Microbiology-reports are not yet available electronically. Only chronic cardiology patients still have a paper record to collect the EKG's. This will remain until a digital EKG-device can be acquired.
In the inpatient clinic paper records are still used. Here the EPR can be only be used for data retrieval, not for data entry, because the many changes that occur in medical staff (residents) are considered a risk: there is too little time to learn them to use the system properly. Despite this risk, it is planned to implement the EPR in the inpatient clinic in 2005, starting with the nurses.

6.1.2. Relevance

All interviewed specialists mention different topics that are important to them, but all these topics serve the same goal: to provide care of high quality. To reach this goal patient information of high quality is needed at all moments that care is provided and at all places where care is provided. Supplying this is the most relevant function of the EPR. What patient information is relevant differs per specialty and specialist; that is why customization is very important to accomplish compatibility with the different ways the medical process is performed.
The topics mentioned are: the failing organization of the hospital, missing a professional challenge, personal attention for the patient, ageing population, cooperation on a regional level and the nurse practitioner. Cooperation among care providers needs good communication and information exchange.

[12] Endocrinology deals with the endocrine glands, which produce a various kind of hormones, like insulin and cortisone. Diseases treated by an endocrinologist are e.g. diabetes and Cushing's disease.
[13] Hematology deals with disorders of the blood and blood-producing organs. Oncology concerns malignant diseases, also called cancer. Leukemia is an example of a hematological-oncological disease.

At the moment the EPR supports the information exchange passively by making it possible to share the patient information. A tool for communication support is not available yet.
When looking at disturbances and exceptions in the medical process, all specialists name different problems. A problem the cardiologist faces is the large amount of patients coming without being referred. These people are not refused and cause long waiting lists. Other problems mentioned are: shortage of staff, shortage of money to invest, the merger of hospitals and the large amount of paperwork. The last problem is partly solved by the employment of the nurse practitioners and partly by automation. The specialists feel that these problems affect the quality of delivered care, because they cannot pay as much attention to the patients as they should or cannot offer the treatment they need.

6.1.3. Requirements

The medical process is an information-intensive process. This means that a high quality of patient information is needed to provide a high quality of care. One element of quality is completeness of information. Although the EPR does not contain all patient information yet, it provides the physician with much more and more accurate information that the paper record can. For instance, a strong need for surveyable information about the episode before the specialist is consulted exists. The quality of the information supplied by the referring GP varies widely. Even the reason for referral and the underlying request is not always clear. Thanks to the EPR an overview of previous specialist's treatment can be gained by scanning the specialist's letters of most specialties.

6.1.4. Resistance

All three specialists can be marked as early adopters of the EPR (Rogers, 1995). They are all very much in favor of the implementation of the EPR, because it improves the quality of care they can provide by supplying them with a higher quality of information.
A negative aspect of the introduction of the EPR is the time it takes to organize the system and the time needed to fully learn to use it. This is also seen as the main hurdle to take when implementing the system in the entire hospital. But the interviewed specialists think that the invested time is soon compensated by the time saved when composing letters. Also resistance, caused by fear of computers and the unknown in general, is expected. To reduce this resistance the compatibility and ease of use must be very high.
Immediate tangible benefits seem not very important for these early adopters, but are probably more important for those physicians who are less convinced of the usefulness of the EPR.
Before the hospital management decided to implement the EPR in the entire hospital the internists had started using the system on their own expense. In this initial stage the support of the supplier was very intensive, by that supporting maximum trialability. Now the outpatient clinic for Internal medicine serves as a pilot for the other specialties, supporting the idea of observability.
Another cause of resistance related to the EPR was the fear to loose the professional autonomy by far-reaching standardization. This does not concern fear for intrusion with medical decision-making, but the wish to keep a personal style and the possibility of making personal notes in free text. The EPR does not offer decision-making support nor clinician reminders, so the topic of interfering with medical decision-making is not relevant yet.

6.1.5. Resources

The hospital-wide implementation of the EPR is a project initiated by the hospital management and is supported by supplying human and financial resources. The IT-department supports the users as far as possible, but lacks expertise on the medical user's level. The initial training costs little time, but it takes time to implement the use of the system fully in the working procedures and learn to use the system properly. Also many questions and ideas for improvement arise while using the EPR. The supplier of the system gives this support, but the amount of support is limited for financial reasons.

6.1.6. Conclusions

A great variance exists in the way specialists – even of the same specialty – execute the medical process. Routine jobs and paperwork are preferably delegated to nurse practitioners. The main problems are of organizational nature: no threshold for patients, shortage of staff, shortage of money and the recent merger of hospitals.
From the interviews can be learned that performing a good job, i.e. providing good care of high quality, is the most relevant issue for these specialists. Second most relevant issue is to perform this job under acceptable conditions, meaning being on good terms with the environment and not being bothered with administrative or other routine tasks, which can also be performed by non-academic staff. The EPR is judged on its usefulness in supporting the medical process. Supplying complete patient information on every location is seen as a major improvement. The easy composing of letters is seen as a tangible reward for the effort of data entry. Composing letters in the EPR rewards the specialist in two ways: he gains several hours spare time a week and he has to spend less time on a boring task. For the supporting staff of the hospital the easy composing of letters means that the traditional backlog of letters disappears.

The EPR succeeds for a large extent to satisfy the information needs of the specialist. By making sharing of patient data possible the EPR is also a very helpful – although passive – tool for communication and information exchange and by that serves as a supporting tool in cooperation processes between care providers. The professional autonomy should not be threatened by far-reaching standardization. Compatibility is essential; the main strength of the used EPR is the customization it offers. Customization not only serves the compatibility to the different ways different specialties work, but also adaptability to specialists with little computer-skills. The EPR is very flexible and can be customized to each way of working. But this customization takes time and could slow down the further implementation. The immediate experienced benefit is the time saved when composing letters.

6.2. Results of the questionnaire

Nine specialists, seven using system A and two using system B, filled out the questionnaire. The total and average scores are listed in the table in appendix D. In this section a summary of the answers will be given and discussed.

6.2.1. Use of Information systems and functions

Eight specialists use office applications and also eight specialists report to use an EPR. None of them uses a financial system. All specialists from hospital A use the EPR for DBC-registration, five also use the EPR for complication-registration. Six use the EPR to compose letters. The same amount uses the EPR instead of a paper record. Their patients only have a paper record to store reports (e.g., microbiology) that are not yet available electronically. Two specialists reported to be in the transfer-phase from paper to electronic record.

6.2.2. Purposes of the EPR

The specialist and his colleagues use the documented patient data to perform the medical process. A second purpose of the use of the EPR is to document care provided to be able to account for one's doings. Other uses have a “partially disagree” to neutral score on average.

6.2.3. Task support satisfaction

Those specialists that use the EPR in hospital A. instead of the paper record agree with the statements that they can perform their tasks easier and faster. The general opinion of all medical specialists is that the EPR is useful to their job. They don't want to do without the EPR anymore, although using the system takes more time during the patient encounter. When asked about the fit between the offered information and functions with the working

process, the average score is neutral. The cardiologists are rather negative about the offered functions, because they miss essential information and functions. The internists are more positive, although not completely satisfied. The function of the EPR that is appreciated most is the availability of all information wherever needed. The availability of information whenever needed scores neutral to positive on average, especially the cardiologists disagree. In the open questions the easy composing of letters is mentioned as a useful function. Functions and information that are missed are microbiological reports, storage and view of images, communication support and the linkage with other systems such as pharmacy systems. No respondent mentioned the missing of active elements like decision support or medical alerts.

All respondents are asked to write down the advantages and disadvantages of the paper and the electronic record. The results of this comparison are listed in table 20. The total of all nine specialists is listed in the second column (N = 9); the answers of the specialists who do not use a paper record anymore can be found in the fifth column (N = 6).

Advantages of the paper-based record	**N = 9**	**100%**	**N = 6**	**100%**
Easy to retrieve information	*5*	*56%*	*4*	*67%*
Disadvantages of the paper-based record	**N = 9**	**100%**	**N = 6**	**100%**
Only one copy, often not on the right spot	*6*	*67%*	*4*	*67%*
Illegible	*3*	*33%*	*2*	*33%*
Test results are not in the record (yet)	*2*	*22%*	*2*	*33%*
Advantages of EPR	**N = 9**	**100%**	**N = 6**	**100%**
Patient data present everywhere	*5*	*56%*	*4*	*67%*
Easy composing of letters	*4*	*44%*	*4*	*67%*
Legibility	*3*	*33%*	*2*	*33%*
Orderly	*2*	*22%*	*2*	*33%*
Improves quality	*2*	*22%*	*2*	*33%*
Patient data of colleagues available everywhere	*2*	*22%*	*2*	*33%*
No searching for records	*2*	*22%*	*2*	*33%*
Disadvantages of EPR	**N = 9**	**100%**	**N = 6**	**100%**
Costs more time at the start	*6*	*67%*	*3*	*50%*

Table 20. Advantages and disadvantages of the paper and electronic patient record.
Not every respondent answered the open questions. The answers are later categorized. Only answers with a score of 33% or higher are listed. First the numbers of all nine respondents are given. The two last columns reflect the answers of those respondents who only use the Electronic Patient Record and no paper record.

6.2.4. Ease of use and customization

The average score on ease of data retrieval, compared to the paper record and legibility is positive. This seems to contradict with the findings in table 21, where the easy retrieval of information is considered to be the main advantage of the paper record. The explanation for this contradiction is probably that the paper record is familiar to the users and physicians know where to look for the information they want. But they will only succeed in retrieving the information from the paper record, when it is there, legible and complete, which is often not the case. Retrieving information from the electronic record takes some learning time and effort to type, but the user can be sure that the information is available.
The respondents agree that you get skilled by using the system. On the same time the score on the statement that little or no training is required to use the EPR is neutral on average, but the internists using system A disagree with this and the cardiologists and users of system B agree. The scores for ease of data retrieval, data entry and data presentation vary widely per item and per individual. It seems that the more experienced users have learned how to use the system and are positive about the system in general, but also discovered points to

improve. Only two users of system A[14] personalize the interface. The most likely reason is that the others do not know how or do not dare to make changes as long as the system works.
The score for ease of data entry is neutral and by that less positive than for data retrieval. The score on interface satisfaction is also neutral on average. The specialists use both keyboard and mouse for entering and retrieving data, but prefer to use the mouse. More advanced features, like speech recognition, wireless connection and working at home are not available yet.

6.2.5. Privacy of the physician

Four of the specialists strongly disagree with the statement that it is undesirable that others can get insight in the way they work. The other five like the “look over their shoulder” less. According to the specialists the awareness of the fact that others can view the data they entered has a positive effect on the quality of the data. Physicians document their findings more carefully.

6.2.6. Adoption decision

The specialists do not agree whether they have the individual choice to use the EPR or not. One third say they are free to choose; the others strongly disagree. Also about the reason to start using the EPR two groups have opposite opinions. Half (probably the initiators) strongly disagree with the statement that they use the EPR because they are demanded to do so and the other half strongly agrees with this statement. The main reason for continued use of the EPR is that the advantages of the EPR are far greater than the advantages of a paper record and far greater than the disadvantages of an EPR.

6.2.7. Conclusions

Two-third of the medical specialists use the Electronic Patient Record as the main patient record. The main advantage of the electronic record is that it provides the physician with the patient data anywhere and anywhere he needs the information. This advantage seems to be valuable enough to compensate for the effort and time it costs to learn to use the system.
The patient data are also easier retrieved from an electronic record than from a paper record. A third advantage is that the EPR reduces the time needed to compose letters. The EPR does not make more time available for patient care. The score on interface satisfaction and ease of data entry is neutral on average, this means that not all users are satisfied with the way they have to use the system. The positive score on usefulness and on advantages of the EPR show that relevance compensates for ease of use. From the answers on the question what functions are missed can be learned that first of all physicians want one complete patient record for data entry and retrieval, and which is accessible whenever and wherever needed.
Some physicians do not like to share their recordings with others, but they all agree that this sharing makes them document the patient data more carefully, which improves the quality of the information. The questionnaire also shows that the medical specialist is in fact not very autonomous in making decisions about the adoption of an EPR.

6.3. Conclusion on the conceptual model

In this section the results of the interviews and questionnaire are combined to discuss the correctness of the elements of the conceptual model. Each item of the conceptual model will be discussed first. Second, the usefulness and correctness of the conceptual model as a whole will be discussed.

[14] System B cannot be personalized (M.J. van der Meijden, personal communication, 2003).

6.3.1. Results per item of the conceptual model

Relevance: Relative advantage	Value-added data

To the presented data no extra value is added, like statistics. In comparison to the paper record the presentation of more data, like the letters of most specialties, adds value.

Relevance: Perceived usefulness	All relevant patient data is shown in a integrated way

This item contains two dimensions: showing all relevant data and integration of data. These two elements will be discussed separately. From the interviews can be learned that supplying complete patient information on every location is seen as a major improvement.
The integration and overview of data is especially relevant to physicians who deal with complex disorders, like the internists. Paper records and letters of internists who do not use the EPR yet are scanned. The EPR also serves as a viewing box on the HIS: this makes a combined view of data entered by physician and lab-results etc. possible. Integration here means showing data in different combinations; no active integration or corrections take place. Not all patient data is available digitally yet. Especially the cardiologists miss several kinds of relevant data.

Relevance: Perceived usefulness	Access anywhere
Relevance: Perceived usefulness	Access anytime

The main disadvantage of the paper record is that only one copy exists and that it can only be on one spot at the time. This means that it only one person at the time can use it and that it often cannot be completed with test-results when these arrive, because the record is in use by someone else. Also the administrative handling after a patient is discharged from hospital cannot be completed as long as the record is in the specialist's office waiting for the finishing of the discharge letter. This problem is overcome by the EPR, making the access anywhere anytime the most valuable function. Data retrieval is possible anywhere, data entry only in the outpatient clinic.

Relevance: Perceived usefulness	Access to medical knowledge

In hospital A physicians have access from their workstation to scientific literature. This is appreciated very much by the specialist who reported this function.

Relevance: Perceived usefulness	Decision support
Relevance: Perceived usefulness	Clinician reminders

None of the respondents or interviewees complained or made a remark about the fact that neither system has a decision-support system or supplies medical alerts. When looking at the named problems these active components seem not be missed. Access to medical knowledge seems to be enough.

Relevance: Perceived usefulness	Communication support

The EPR supports the information exchange in a passive way by giving access to all patient data. Sharing the patient records enables cooperation between nurse practitioners and physicians. The EPR in hospital A does not actively support communication; several physicians miss this functionality.

Relevance: Net benefits	Saving time

Does the EPR solve the here and now problems of the users? Time is an important issue. Thanks to the EPR the medical specialist can save several hours a week on composing

letters. This does not mean that the medical specialist spends more time during the patient-encounters. On the contrary, using the Electronic Patient Record probably takes more time than using the paper record, when seeing a patient. But it reduces working overtime. An interviewed specialist told that the work of the medical secretaries had greatly reduced. Since these employees are often skilled nurses, they can be deployed in direct patient care and by that the EPR indirectly can help to solve the shortage of staff.

Relevance: Net benefits	Easy reporting

A second important advantage of the EPR is the easy composing of letters. This function saves a lot of time, but also reduces the amount of boring work, and sets the administrative staff free of the backlog of letters.

Relevance: Compatibility	Customization, user control
Relevance: Compatibility	Fit actual work process and cognitive process

Compatibility is considered very important. A medical specialist and an IT-professional customize system A before a specialty starts using the EPR. But fear to change a working system hinders the physicians to personalize the system further, despite the fact that this is considered to be one of the strengths of system A.
In fact the accessibility of patient data anywhere, anytime is a change in the working process already, but a vary valuable one and the main reason for the use of the EPR. Not all desired data or functions are available yet; this is a real problem.

Requirements:	Privacy protection

The questionnaire and interview did not comprise questions about the patient's privacy, because law protects the patient's privacy. And discussing how this is implemented does not fit in this research.

Requirements: System quality	No downtime

From the interviews can be learned that downtime is not tolerated.

Requirements: Information quality	Complete, correct data

The questionnaire and the interviews showed that the availability of correct, complete patient data everywhere every time is considered the main reason for using the EPR. The investigated EPR's did not meet this requirement of completeness fully yet, but it provides the physician with much more and more accurate information than the paper record can. Images of endoscopies and ultrasound cannot be entered and EKG's and microbiological reports still fail, causing reduced satisfaction with the EPR. Especially cardiologists miss these essential data. Another reason why the quality of patient data is improved by the EPR, is the more accurate documentation of patient data and provided care by the physicians. Knowing that colleagues will be able to view their data makes them report more carefully.

Requirements: Information quality	Robustness

The questionnaire and interview did not comprise questions about robustness.

Requirements: Ease of use	Easy, flexible data entry

Data entry is not a problem on average, but the scores on this item vary widely. As one respondent wrote on the questionnaire form: "Copy and paste is still to difficult for me". Physicians who are not trained to use computers and type with two fingers, searching the keyboard for the right letters need a lot of time for data entry. Only mouse and keyboard are

used for data entry and retrieval, but the mouse is favored for both. To enter text speech recognition would solve the problem of physicians with little typing-skills. Another attempt to overcome the problem of data entry is to maximize the customization in such a way that typing is hardly necessary.

Requirements: Ease of use	Easy, quick retrieval

Retrieving information from the Electronic Patient Record is easier than retrieving information from a paper record.

Causing minimum resistance	No interference with medical decision-making

Neither EPR has a decision support system. This means that using the Electronic Patient Record does not interfere with medical decision-making. In the EPR's that were investigated the data entered by physicians were only accessible by physicians from the same specialty or fellowship and some authorized nurse practitioners. All physicians could see the specialist's letters. This means that there is little change in 'privacy', seen from a physician's perspective.
From the questionnaire can be learned that half of the specialists favor sharing records and half of them do not. To reduce resistance it is recommended to respect the need for different levels of access (e.g., general, department, specialist (Biesboer and Vos, 2000)).

Minimum resistance	Immediate tangible benefits

Immediate tangible benefits seem not very important for the interviewed specialists, but are probably important to persuade other physicians to invest time in implementing the use of the system. Two "tangible benefits" are clear: 1. The time saved for composing letters, and 2. The time saved for searching records or patient data.

Minimum use of resources	Minimal training

The EPR seems easy to understand, but training is needed to get used to the change in working process. Reading and writing in the paper record has become second nature to physicians and it will take considerable time before using the EPR has become second nature too.

Resources: Service quality	Adequate user support

The EPR-users in hospital A. have a special status, meaning that the IT-department will restore technical problems within an appointed time. This does not include support in the "medical" use of the system. The supplier of the system gives this kind of support. The users of system A. are very satisfied about the given support of the supplier in the initial phase. But now the implementation comprises the entire hospital, this support is restricted for financial reasons. The users of system B. are less satisfied about the support of the supplier[15].

6.3.2. The adjusted conceptual model

Based on the discussion of the separate items of the conceptual model, the importance of the each item for the adoption-decision of the Electronic Patient Record is established. Items that form the main reason to adopt the Electronic Patient Record are labeled as "very important". Items marked "important" support the decision to use the EPR, but are in itself not enough to make the decision. Items labeled "appreciated" can be seen as benefits or "rewards" for using the EPR, but do not compensate for missing importance.

[15] M.J. van der Meijden, personal communication, 2003.

From table 21 can be learned that relevance is the major argument for implementing the EPR. The item “all relevant patient data are shown in an integrated way” is split in two items, namely “all relevant patient data are available” and “surveyable patient data”, because these items are of different importance. The item “value-added data” is left out, because no extra value is needed. Having access to all relevant data anywhere, any time is extra value enough. Relevance compensates for ease of use. Also “decision support” and “clinician reminders” are left out. These functions are not mentioned as missing functions. From the case study can be learned that it is more important to realize the basic functions first, than to spend energy on advanced features.

REQUIREMENTS OF PHYSICIANS FOR THE ELECTRONIC PATIENT RECORD (adjusted)		
User demands	**Translated to EPR requirements**	**Case study result**
Relevance: Perceived usefulness	All relevant patient data available	Very important
	Surveyable data	Important
	Access anywhere	Very important
	Access anytime	Very important
	Access to medical knowledge	Appreciated
	Communication support	Important
Relevance: Net benefits	Saving time	Appreciated
	Easy reporting	Appreciated very much
Relevance: Compatibility	Customization, user control	Important
	Fit actual work process and cognitive process	Very important
Requirements:	Privacy protection	Not investigated
Requirements: System quality	No downtime	Important
Requirements: Information quality	Complete, correct data	Very important
	Robustness	Not investigated
Requirements: Ease of use	Easy, flexible data entry	Moderate important
	Easy, quick retrieval	Moderate important
Causing minimum resistance	No interference with medical decision-making	Important
Minimum resistance	Immediate tangible benefits	Appreciated
Minimum use of resources	Minimal training	Important
Resources: Service quality	Adequate user support	Important

Table 21. The adjusted conceptual model based on the case study results.

The main requirement is complete information. Correctness is not discussed separately, because it is considered to be an undisputable requirement. Ease of use is desired, but not crucial. Probably a basic level is sufficient. Ease of use enhances satisfaction. The quality of entered information is higher, because of more careful recording by the physicians. The protection of the patient's privacy is not discussed, because this is regulated by law.

As is said before, relevance is the major driver for innovation. Resistance can be overcome by high relevance. Observability and immediate tangible benefits help to fasten decision-making or acceptance. Trialability is useful in the initial, experimenting phase, preparing the pilot. Professional autonomy must be respected.
In this stage the EPR does not interfere with medical decision-making, but sharing information and standardization already cause some resistance.

Time is scarce, and due to the shortage of staff, can time invested in the EPR, not be compensated by others. So physicians must be convinced of the benefits of the system before they are prepared to invest time. Saving time in the rest of the care process does not directly benefit the physician, but when it can reduce the problem of shortage of staff it does indirectly. Adequate user support will enhance satisfaction.

6.4. Evaluation of the cases study-tools

6.4.1. USE IT-tool

The main purpose of the USE IT-tool was "to reveal the user characteristics of the physician in order to check the validity of the user demands as listed in the first column of the conceptual model. Especially the relevance of problems and solutions can be best established by interviews" (section 5.2). When looking at the results of the USE IT-interviews, one can confirm that the tool served its purpose. Especially visiting the interviewee in his own environment and the personal contact add value to the given answers, by making it easier for the interviewer to put one self in the position of the physician. A difficulty that occurs when interviewing is the limited time available. For this reason questions have to be skipped. What questions are skipped is decided during the interview by the interviewer. This makes it harder to compare the interview results with each other.
Initially, the USE IT-tool did not include questions about the adoption-decision. The question is added by the author and proved to be valuable.

6.4.2. Questionnaire

The questionnaire basically measures the level of satisfaction and not so much what specifically causes satisfaction. In that sense the questionnaire helps to answer the research questions in an indirect way. But asking directly about functions would make the questionnaire too long and has the hazard of prompting favorable answers.

Not asked is how long the EPR is used for DBC-registration and how long as full patient record. Also not asked is whether the respondent considered himself as a skilled user or a beginner. These questions are necessary for interpretation and are missed.

7. Conclusions: What makes doctors use the EPR?

In this chapter the conclusions of the research are presented as an answer to the research question. Also the value of the conceptual model will be discussed. After a personal reflection on the research, some remaining questions for future research will be discussed.

7.1. The relation between the user and the product

The objective of the research was to reveal the product characteristics of an Electronic Patient Record that determine the successful use by physicians in relation to their user characteristics. The research question was:

What product characteristics of an Electronic Patient Record and what user characteristics determine the successful use by physicians?

The two elements of the research question: user and product characteristics are discussed separately, followed by conclusions on the conceptual model.

7.1.1. User characteristics of the physician

A physician can be characterized as a medical professional, who's first objective is to provide a high quality of care to his patients and who values his professional autonomy. The medical process, performed by medical specialists is an information-intensive process with high uncertainty and probability. It is also the central process in the whole care process and enables the start of other processes, like laboratory investigations and paramedical treatment. The patient record is used in every phase of the medical process.
The main problems a medical specialist faces are shortage of time, staff and money, and inadequate patient data, resulting in the incapability to provide the desired quality of care.
As was expected from literature relevance proved to be the major criterion for the adoption and success of the Electronic Patient Record. Resistance to innovations or the use of information systems hardly exists, but infringement of the professional autonomy can cause resistance.

7.1.2. Product characteristics that satisfy the physician

From the research it can be concluded that relevance to the medical specialist means the accessibility of all relevant patient data anywhere anytime within the hospital. By being able to meet this requirement the EPR solves the problem of the inadequate patient data. The EPR helps only to solve the problem of shortage of time and staff in an indirect way, i.e. by reducing the time nurses have to spend on searching for records and completing these and by that the EPR helps to make more time of nurses available for patient care.
The time saved on writing letters is the 'tangible' reward for making this decision. To make the EPR-implementation a success for physicians three requirements have to be met:

1. The EPR must contain <u>all</u> relevant data and functions, on all working locations and 24 hours a day.
2. Using the EPR must be compatible with the medical process of each individual specialist.
3. The EPR must allow different levels of authorization to protect the professional autonomy.

Other requirements that influence the success of the implementation are: communication support, customization, minimal time required for training and adequate user support. The access to medical knowledge and tangible benefits like saving time from composing letters are very much appreciated, but are not decisive elements for the success. Active elements like decision-support and clinician reminders are not missed. In contrast with what was expected from literature, ease of use and especially data entry proved not to be a major

problem for the investigated specialists. But these specialists expect that data entry could slow down the further implementation among fellow specialists.

7.1.3. Conceptual model

Table 22 shows the adjusted conceptual model. The objective of the conceptual model is to explain success and failure of the use of EPR's by physicians. The first version based on the literature study proved to be too general and in this version no distinction was made in the degree of importance or the kind of value each item represented. After the case study the conceptual model could be made more specific and of each item the importance and meaning could be established. Further research should prove whether the conceptual model applies to all medical specialists or all physicians and whether the model can serve as an advice tool.

7.1.4. Evaluation of literature

Literature on IS-success

The USE IT-model proves to give the best explanation for the successful use of the Electronic Patient Record (Schuring and Spil, 2003). From the factors influencing the persuasion stage in the Innovation-Decision Process of Rogers (1995) compatibility, trialability and observability seem to be confirmed. When relative advantage is interpreted as perceived usefulness this factor is confirmed too. The influence of complexity is not investigated. The Reformulated Model of IS Success of DeLone and McLean (2002) is right in emphasizing the role of the user, but pays too little attention to the characteristics of the user. The framework of Saarinen and Sääksjärvi (1992) describes success on an organizational level and not on the level of the end-user. Although the case study was not focused on the organizational level, some information about this level can be gained from the interviews. Three factors explaining success of the use process match with the investigated case: mature IS function, high level of management support and a high experimentation rate. The dimensions of user satisfaction defined by Garrity and Sanders (1998) helped to adequately measure the level of user satisfaction, but provide little support in explaining what causes user satisfaction.

EPR-literature

The expectations and demands in literature are much higher than in practice. The basic function of having all information available proved to be a big step forward in the case study. Successful use of the EPR does not mean providing advanced features, but doing the simple thing perfect. An explanation for the found difference might be that in literature often not a clear distinction is made between requirements following from the primary use of the EPR by the physician and requirements following from the use for other purposes. Data entry by physicians is considered a big problem in literature, but is not proved in practice; although the case study suggested that data entry of text might become a problem in the further diffusion of the EPR. The problem of data entry seems not a matter of resistance, but merely caused by lack of computer-skill. In the case study the problem is anticipated by further customization of the interface.

7.1.1. Evaluation of research

Because the time that could be spent on the research was limited, no attention is paid to the implementation process, based on the assumption that doctors decide for themselves. From hospital A can be learned that the initial decision was made individually based on the need to solve an urgent problem, but by using the system the usefulness and relevance became the main arguments for expanded use. For the diffusion among other doctors in the hospital strong top-management support is needed, because they must supply the resources. Also the support of the IT-department is needed to maintain the technical facilities. The project in hospital A shows the value of starting a pilot first and planning diffusion second. The pilot

shows the relevance (observability), and requirements can be analyzed; the product can be customized and mature in practice (trialability).

Personal reflection on the project

Because of my special position being on the same time a student and a colleague-researcher, I had the liberty to choose and design my own assignment. I appreciated this freedom very much, because it gave me the opportunity to spend my limited time on a topic that really interested me. But the consequence of this freedom was, that I had to explain and sometimes defend what I was doing, but also that the understanding and expectations of the coaches, about the assignment and its outcomes, developed during the execution of the project, and that sometimes suggested changes could not be made anymore.
Another problem I encountered was, that, being a trained as a physician myself, I had to make my knowledge of healthcare and physicians much more explicit.
A third problem I faced was to find cases. It is a pity, that I could not test my questionnaire and the conceptual model in more fellowships and hospitals.
Despite these problems, I really enjoyed working on this assignment. I learned a lot, from literature, from the case study, but most of all from the discussions with my coaches, which forced me to defend, explicate and justify my work.

7.2. Future research

The research did not pay attention to the influence of aspects of the development and implementation process on the success of the EPR-implementation. The history of the EPR-implementation in hospital A learns that these processes can not be ignored (Van de Stadt and Jansen, 2003). It would be interesting to find out what the relation is between the development and implementation process with the findings of this study.
It would also be very interesting to investigate whether having USE IT-interviews before the start of the requirements analysis will improve the quality of the analysis, because the expectations and objectives of the new system are clearer to the developers and future users.
And of course it would be very interesting to perform more case studies to see whether the conceptual model can fulfill its function.

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Appendices

Appendix A : Literature

Appendix to chapter 2.

Almost all mentioned elements of IS innovation can be seen in the 3D-model of Ballantine (et al., 1998). In this model the involvement of the user is a repetitive item. The 3D-model distinguishes three levels (or phases): development, deployment and delivery (see figure). This model not only describes the factors that determine success, but also the factors that influence the decision to go from one level to the other.

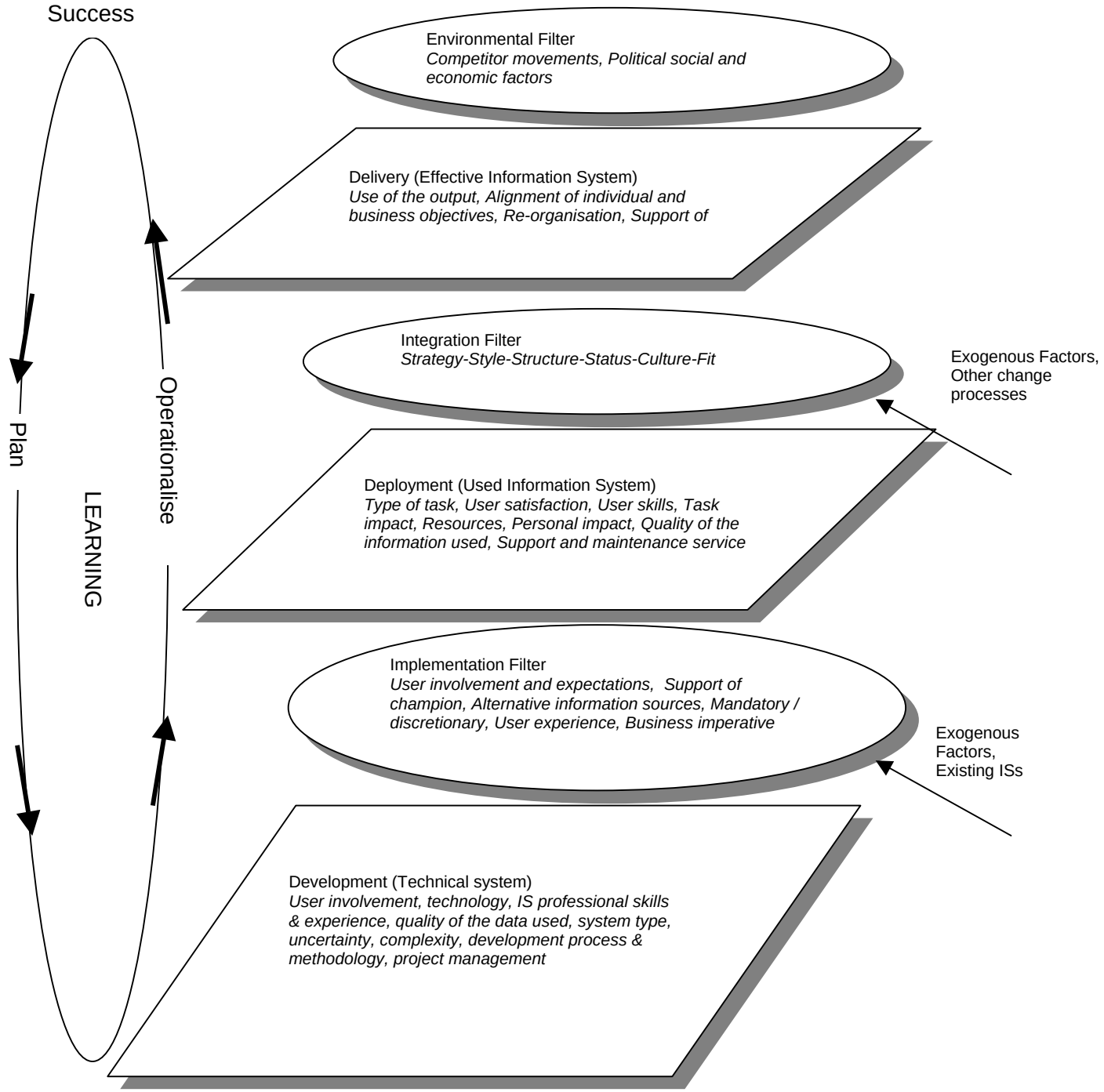

Figure A1. Combination of the 3-D Model of Information Systems Success and the 3-D Model Expanded (Ballantine et al., 1998). The 3-D model is cyclic and iterative: the development of an IS is

seen as an organizational learning process, that never ends. But each time the cycle starts again, the learning process is enriched with previous experiences. In this way the model also describes the IS-life cycle.

Appendix to chapter 4.

In this appendix the complete tables from which the tables in the text are summarized are listed.

Table A6. Objectives of a Medical Information System based on (Collen, 1970).

Immediate Objectives of MIS	
The usual objectives of an MIS are to	
a)	Communicate patient data from the professionals providing medical care into the patient's computer medical record and to other professionals, and to hospital services.
b)	On demand or on schedule, communicate information from the patient's computer medical record to professionals and hospital services.
c)	Establish files and communicate information for scheduling of patients, personnel, and medical care services. Communicate between services.
d)	Establish a medical database that has a high utility for medical services for the individual patient and physician.
e)	Establish a medical database the can fulfill research objectives for clinical epidemiological, and health services research.
f)	Establish a database for business and administrative functions, including projection of needs and planning for services.
g)	Improve the cost and quality of medical services.
h)	Have capacity for an increasing number of patients and of doctors, and for progressive expansion of the health service system subcomponents.

Table A7. Primary uses of the patient record. Based on Box 2-2A (Dick et al., 1997)

Primary uses of patient records (Box 2-2A)
Patient Care Delivery (Patient)
Document services received
Constitute proof of identity
Self-managed care
Verifying billing
Patient Care Delivery (Provider)
Foster continuity of care (i.e. serve as a communication tool)
Describe disease and causes (i.e. support diagnostic work)
Support decision making about diagnosis and treatment of patients
Assess and manage risk for individual patients
Facilitate care in accordance with clinical practice guidelines
Document patient risk factors
Assess and document patient expectations and patient satisfaction
Generate care plans
Determine preventive advice or health maintenance information
Remind clinicians (e.g., screens, age-related reminders)
Support nursing care
Document services provided (e.g., drugs, therapies)
Patient Care Management
Document case mix in institutions and practices
Analyze severity of illness
Formulate practice guidelines

Manage risk Characterize the use of services Provide the basis for utilization review Perform quality assurance *Patient Care Support* Allocate resources Analyze trends and develop forecasts Assess workload Communication between departments *Billing and Reimbursement* Document services for payments Bill for services Submit insurance claims Adjudicate insurance claims Determine disabilities (e.g., workmen's compensation) Manage costs Report costs Perform actuarial analysis

Table A7a. The paper and electronic patient record compared (Van Ginneken and Moorman, 1997).
The table relates to the paragraph between table 7 and 8.

Ways the patient record is used
Supporting patient care: A source for evaluation and decision making A source of information that is shared among care providers *A legal report of medical actions.* *Supporting research:* Clinical research Epidemiological studies Assessing quality of care Post-marketing surveillance of drugs *Educating clinicians* *Healthcare management and services:* Providing support for billing and reimbursement A basis for pre-authorization by payers Providing support for organizational issues Providing support for cost management

Table A10a. Quality aspects of the paper medical record (Tange, 1997).
* = disagreement between (Tange, 1997) and (Dick et al., 1997).
The table relates to the paragraph between table 10 and 11 in section 4.3.

Satisfactory items of paper records	**Items of paper records that need improvement**
General aspects 1. Availability on any time 2. Completeness of documentation of diagnostic interventions* 3. Completeness of documentation of therapeutic interventions* 4. Reliability of data* 5. Timeliness of data*	*General aspects* 1. Completeness of documentation of decisions made 2. Completeness of documentation orders made 3. Completeness of documentation of plans made 4. Privacy protection 5. Risk of loss of medical records

Data entry qualities 6. Ease of data entry 7. Speed of data entry 8. Flexibility in recording which data to register 9. Flexibility in recording in which level of detail 10. Flexibility in recording in which words 11. Flexibility in which place *Information retrieval qualities* 12. Ease of retrieving of own data* 13. Legibility of own handwriting* 14. Speed of getting a first impression of present state	6. Risk of loss of medical data *Data entry qualities* No improvement needed *Information retrieval qualities* 7. Ease of retrieving other's data 8. Legibility of other's handwriting 9. Speed of getting a first impression of the progress of treatment* 10. Speed of getting a full impression of the progress of treatment 11. Speed of getting a full impression of the present state 12. Speed of finding specific data 13. Speed of determining absent data 14. Impediment of information retrieval by overload of irrelevant details

Table A12a. The paper and electronic patient record compared based on Van Ginneken and Moorman (1997).

Advantages of paper records	**Disadvantages of paper as a storage medium for patient data**	**Advantages of CPR's**
1. They can easily be carried around, 2. Much freedom in reporting style, 3. Easy data browsing. 4. Requires no special training, and 5. Never 'down' as computers sometimes are.	1. The record can be only at one place at a time: It may not be available or it may even be missing. 2. The contents are in free text; hence they are; – variable in order, – possibly illegible, and – possibly ambiguous. 3. For scientific analysis, the contents need to be transcribed, with potential errors 4. Paper-based notes cannot give rise to active reminders, warnings, or advice.	1. Simultaneous access for multiple locations, 2. Legibility 3. Variety of views on data, 4. Support of structured data entry (SDE), 5. Decision support, 6. Support of data analysis, 7. Electronic data exchange and sharing care support.

Table A15. Design prerequisites for Electronic Patient Records (Metzger and Teich, 1995).

Design Prerequisites for Patient Care Information Systems (Metzger and Teich, 1995)
• Patient care information systems must be available whenever users need them to manager patient care. • Patient care information systems must be available wherever decisions about care are made. • Patient care information systems must provide quick and value-added access to information. • Patient care information systems must be designed to fit actual patient care processes and work situations. • Patient care information systems must be so easy to use that they require little (or no) training. • Involving physicians with direct entry requires minimizing time and maximizing incentives.

The requirements are further explained:

Ad whenever:
- the system must be reliable, downtime is not tolerated (reliability);
- response time (< 2 sec) must be very low, it also means impatience when having to work through many screens;
- data retention: provide access to patient history for as long as the information is clinically useful

Ad wherever:
- bedside terminals
- workstation in every physicians office and examination room;

Ad quick and value-added access:
- aggregated patient data: analysis, evaluation of clinical pathways and research;
- access to knowledge resources: medical literature, decision support tools.

Ad fit:
- processes must be supported, not individual tasks,
- specialized views of patient data tailored to the care situation
- easy ways for the user to move among tasks so that the system interaction is compatible with the actual work flow;
- system flexibility: differences in information use in clinical practice per specialty and patient approach:

Ad easy to use:
- importance of minimizing training: there is no time to do it, max 1 hour training and learning curve max 2 days.
- intuitive design to reduce memory burden: physicians are likely to call up some clinical applications infrequently, terminology used in practice, synonyms must be accepted
- prompts and cues: understandable and instructional, also error message should give clear instructions
- single interface: for all underlying systems
- online help:
- range of users: novice users and computer literate users! shortcuts, customization, doing it right the first time.

Ad direct entry by physicians:
- need for direct entry: patient information is ideally entered in the computer by its originator at the point of service: timeliness and accuracy. order entry by physicians often triggers alerts and warnings
- minimizing time: it should be easier to use the system than not to use it, both data retrieval and data entry should cost less time.
- order entry: offering "order sets" coupled with specific diagnoses or clinical situations, protocols or guidelines, allow physicians to make "favorites lists"
- patient documentation: physicians are accustomed to handwriting or dictating a freeform narrative in documenting care. structured entry based on menus and user selection of choices works best if the choices can be narrowly defined and displayed in a short list on a single screen, otherwise it is still a problem. Problem lists are easier to enter. Physicians are more willing to enter data themselves when a critical mass of data is in the system. It helps when others help the physicians in the initial phase by entering the historical data of patients.
- modes of entry: keyboard is often preferred. Multiple modes should be available for different tasks

- extra incentives: by providing immediate tangible benefits to the user. e.g.: completed discharge letters are automatically send (by e-mail) to other physicians, financial benefits can be used to reward users.
- clinical pathways: these promise to make the entry of assessments, orders, and progress notes much easier. Only exceptions have to be documented.

Appendix B : The USE-IT interview protocol

Date interview:	
Name interviewer:	
Name interviewee:	
Job interviewee:	
Organization:	

Pp	***Primary Process***
Pp.1	What exactly is your job?
Pp.2	What care do you provide? + to what categories of patients? + distinguish first and later contacts? + are there many exceptions or disturbances?
Pp 3	What is your way of working by giving care? + do you have a steady work routine? + how long takes a patient contact (consult)? + do you use any devices? + are you always in the same location? + do you have to look up or inquire things? + do you have to prepare things? (these aspects are also important to get an impression of the compatibilitydimension)
Pp. 4	Do you use a care protocol or medical guideline for the care you provide?
Pp. 5	Who refers patients to you?
Pp. 6	To whom do you refer patients?
Pp. 7	What other care providers or institutions are simultaneaously involved with the care for your patients, with whom you do not really cooperate? + Do you cooperate are do you work in “parallel”? + for instance: family, other physicians, home care,
Pp. 8	How do you experience the cooperation with other care providers in respect to the providing of the care?
Pp. 9	With what care providers should you cooperate more? Why? + With whom should you exchange more information? What information?
Pp. 10	What do you find important in the contact with other care providers?
Pp. 11	What parties are, in your opinion, steering the care process?
Pp. 12	What exceptions or disturbances cause the failure of the provided care or the failure of the coordination of the provided care

REQ.	***Information quality***
REQ.1	What information about the patient do you need to perform your job properly? What form does this information have? + letter (sent by post or handed over personally) + fax + e-mail + in paper record + in electronic record
REQ.2	What information do you miss when providing care to a patient?

REQ.3	What information do you receive from + the patient? + the patient's surrounding? + other care providers? + with what purpose? + in what frequency? What form does this information have? + letter (sent by post or handed over personally) + fax + e-mail + in paper record + in electronic record
REQ.4	What information do you generate yourself when providing care?
REQ.5	When providing care, what information do you give to: + the patient? + the patient's surrounding? + other care providers? + managers? + external parties (e.g., insurance company, government)? What form does this information have? + letter (sent by post or handed over personally) + fax + e-mail + in paper record + in electronic record
REQ.6	At what moments or performing what tasks do you use a care record (patient record)? + is this record only used for this patient group or this type of care? + is this record only used by your own discipline? + is this record only used in your institution? + is this a paper or an electronic record? + what patient data are registered in this record and with what purpose?

Rel.	**Relevance**
REL.1	What is, regarding this type of care, high on **your own** agenda? + why is this point important for you?
REL.2	What do you experience, **for you personally**, as important in your daily work when you look at the last (three) patients to whom you provided care?
REL.3	A general question, not specific for this type of care: What aspects in the ability to provide care, do you experience as bottleneck or problem?
REL.4	And when looking at individual actions: by executing what actions do you experience bottlenecks or problems?
REL.5	Do you know proposals for improvement, **concerning the whole chain of care**, for which you would do your utmost?
REL.6	Do you know proposals for improvement, concerning **this specific care**, for which you would do your utmost?
REL.7	How important are these proposed improvements in the chain of care in relation to other possibilities to improve aspects of your job? + Can you name other proposals for improvement, which are more important? + Can you name other proposals for improvement, which are less important?
REL.8	What aspect of your job would you miss, if it would be removed?

Com	**Compatibility**
Com.1	What aspects of your job are by your social environment regarded to be important or impressive?
Com 2	For what does your department or do you personally receive explicit appriciation?

RIS	***Resistance***
Ris.1	How do you feel about the use of ICT (computers and internet) in general?
Ris.2	How do you feel about the use of ICT (computers and internet) in the care you provide?
Ris.3	Can you tell me what was the most important reason to start using an EPR or ICT? + advantages of the system or product + at the instance of colleagues
Ris.4	Do you experience obstacles when implementing innovations?
Ris.5	How much time do you think you can find to implement the changes, that will occur when introducing innovations and ICT in health care?
Ris.6	Are you stimulated by your colleagues or managers to participate in changes?
Ris.7	Can you name other innovation projects, this organization is working on? + are these equally important (or more or less important)?

Res.	***Resources***
Res 1	What ICT-facilities do you have at your disposal at your workplace?
Res. 2	What of these ICT-facilities do you use when providing care?
Res. 3	Is the technical support sufficient, considering the level and availability?
Res. 4	Do you think you will have enough time and money for training, when necessary?

Is there anything you would like to add?

Appendix C: Questionnaire

Enquête Elektronisch Patiënten Dossier

Geachte heer of mevrouw,

Deze enquête meet het gebruik van een Elektronisch Patiënten Dossier door artsen en de tevredenheid hierover. De gegevens van de enquête worden gebruikt voor wetenschappelijk onderzoek en niet voor commerciële doeleinden. Het invullen kost ca. 10 – 20 minuten.

Uw antwoorden worden anoniem verwerkt.

Indien u opmerkingen of vragen heeft over de enquête of het onderzoek, kunt u die daarvoor de achterzijde gebruiken of contact opnemen met Margreet Michel, m.b.michel@utwente.nl, tel. 053-489 4134.

Een verslag van het onderzoek wordt u toegestuurd, indien u hieronder uw gegevens invult.

Naam: Dhr. / Mw.

Functie / specialisme:

Ziekenhuis:

Adres:

E-mail:

U kunt de enquête in de antwoordenvelop retourneren of ongefrankeerd versturen naar

Universiteit Twente
Faculteit BBT, BIK
t.a.v. M.B. Michel-Verkerke
Antwoordnummer 323
7500 VB Enschede

Hartelijk dank voor uw medewerking!

Toelichting bij het beantwoorden van de vragen.

Eens / oneens vragen:

U wordt gevraagd het antwoord dat het beste past bij uw mening aan te kruisen.

Indien u het **geheel eens** met de stelling bent, geeft u dit als volgt aan:

eens (X) ( ) ( ) ( ) oneens

Indien u het **gedeeltelijk eens** bent met de stelling, geeft u dit als volgt aan:

eens ( ) (X) ( ) ( ) oneens

Indien u **geen mening** heeft over de stelling of het **noch eens, noch oneens** bent met de stelling, kruist u het middelste vakje aan:

eens ( ) ( ) (X) ( ) oneens

Indien u het **gedeeltelijk oneens** bent met de stelling, geeft u dit als volgt aan:

eens ( ) ( ) ( ) (X) ( ) oneens

Indien u het **geheel oneens** bent met de stelling, geeft u dit aan door het meest rechtse vakje aan te kruisen:

eens ( ) ( ) ( ) ( ) (X) oneens

Ja/ nee vragen:
U wordt verzocht het juiste antwoord te omcirkelen.

Open vragen:
Bij sommige vragen wordt u verzocht een antwoord in te vullen. Indien er niet genoeg ruimte is, kunt u de achterzijde van de pagina's gebruiken.

Gebruikte informatiesystemen en functies

Graag het juiste antwoord omcirkelen

1.1 Maakt u gebruik van onderstaande computerprogramma's bij het uitvoeren van uw taken?

- op het gebied van kantoorautomatisering (b.v. Word, Excel) Ja Nee
- ziekenhuisinformatiesysteem (ZIS), b.v. Hiscom Ja Nee
- financieel systeem Ja Nee
- elektronisch patiënten dossier (b.v. Norma) Ja Nee
- anders: .....

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1.2 Maakt u gebruik van onderstaande delen / functies van het elektronisch dossier (Norma)?

DBC-registratie Ja Nee

Managementinformatie voor uw eigen maatschap Ja Nee

Versturen korte berichten (Notification Manager) Ja Nee

Ontslag- en andere brieven opstellen Ja Nee

Afspraken maken Ja Nee

Complicatieregistratie Ja Nee

Coderingslijsten Ja Nee

Vastleggen van:

- anamnese Ja Nee
- lichamelijk onderzoek Ja Nee
- differentiaal diagnose Ja Nee
- beleid Ja Nee
- voorgesteld onderzoek Ja Nee
- voorgestelde therapie Ja Nee
- decursus Ja Nee
- behandelplan Ja Nee

Aanvragen van onderzoek

- laboratorium Ja Nee
- röntgen Ja Nee
- P.A. Ja Nee
- anders: .....

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Vastleggen door u zelf verricht onderzoek

- endoscopie beelden Ja Nee
- endoscopie verslag Ja Nee
- echoscopie beelden Ja Nee
- echoscopie verslag Ja Nee
- ander onderzoek: .....

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.....

Andere functies: .....
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1.3 Voor welke functies of in welke situatie gebruikt u een papieren dossier?

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Doeleinden van het elektronisch patiëntendossier

Graag het juiste antwoord aankruisen.

2.1	De door mij ingevoerde patiëntgegevens, gebruik ik voor het eigen medisch handelen (b.v. vervolgconsult, behandeling)	eens ( ) ( ) ( ) ( ) ( ) oneens
2.2	De door mij ingevoerde patiëntgegevens, worden door collega's of andere zorgverleners gebruikt voor hun handelen.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.3	De door mij ingevoerde patiëntgegevens fungeren als opdracht aan andere zorgverleners (b.v. verpleging).	eens ( ) ( ) ( ) ( ) ( ) oneens
2.4	De door mij ingevoerde patiëntgegevens worden gebruikt voor de financiële afhandeling (declaraties, facturering).	eens ( ) ( ) ( ) ( ) ( ) oneens
2.5	De elektronische vastlegging van patiëntgegevens, heeft mede als doel mijn medisch handelen naar de patiënt toe te kunnen verantwoorden.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.6	De elektronische vastlegging van patiëntgegevens heeft mede als doel mijn medisch handelen juridisch te kunnen verantwoorden.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.7	De elektronische vastlegging van patiëntgegevens heeft mede als doel te voldoen aan wettelijke verplichtingen.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.8	De elektronische vastlegging van patiëntgegevens heeft mede als doel te voldoen aan landelijke en andere registraties.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.9	De elektronisch vastgelegde patiëntgegevens geven mij inzicht in de bedrijfsvoering in mijn praktijk.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.10	De elektronisch vastgelegde patiëntgegevens worden door de ziekenhuisorganisatie gebruikt ten behoeve van de bedrijfsvoering.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.11	De elektronisch vastgelegde patiëntgegevens gebruik ik om mijn eigen medisch handelen te evalueren.	eens ( ) ( ) ( ) ( ) ( ) oneens
2.12	De elektronisch vastgelegde patiëntgegevens worden gebruikt voor collegiale evaluatie en toetsing.	eens ( ) ( ) ( ) ( ) ( ) oneens

Ondersteuning van het medisch handelen

Graag het juiste antwoord aankruisen.

3.1	Met behulp van het elektronisch dossier kan ik mijn taken sneller uitvoeren.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.2	Met behulp van het elektronisch dossier kan ik mijn taken beter uitvoeren.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.3	Dankzij het elektronisch dossier duurt een patiëntentraject korter (een patiënttraject duurt van eerste consult tot ontslag of overlijden van de patiënt).	eens ( ) ( ) ( ) ( ) ( ) oneens
3.4	Dankzij het elektronisch dossier kan ik meer tijd aan de directe patiëntenzorg besteden.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.5	Met behulp van het elektronisch dossier kan ik mijn taken makkelijker uitvoeren.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.6	Ik vind het elektronisch dossier nuttig en bruikbaar in mijn werk.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.7	Ik zou niet meer zonder het elektronisch dossier willen werken.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.8	Het elektronisch dossier levert precies die informatie die ik nodig heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.9	Het elektronisch dossier biedt precies die functies / mogelijkheden die ik nodig heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.10	Het elektronisch dossier bevat geen overbodige functies.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.11	Het elektronisch dossier bevat alle informatie die ik nodig heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.12	Het elektronisch dossier bevat alle functies die ik nodig heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.13	Het elektronisch dossier bevat geen overbodige informatie.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.14	In het elektronisch dossier kan ik alle informatie kwijt, die ik op wil slaan.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.15	Op het moment dat ik bepaalde informatie nodig heb, kan ik over al die informatie beschikken.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.16	Op het moment dat ik bepaalde functies wil gebruiken, zijn al die functies beschikbaar.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.17	Op iedere locatie, waar ik bepaalde informatie nodig heb, kan ik over al die informatie beschikken.	eens ( ) ( ) ( ) ( ) ( ) oneens
3.18	Op iedere locatie, waar ik bepaalde functies wil gebruiken,	

zijn al die functies beschikbaar. eens ( ) ( ) ( ) ( ) ( ) oneens

Voor- en nadelen elektronisch dossier

3.19 Welke voordelen ervaart u bij het gebruik van een elektronisch dossier?

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3.20 Welke nadelen ervaart u bij het gebruik van een elektronisch dossier?

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3.21 Welke functies van het elektronisch dossier vindt u het meest nuttig?

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3.22 Welke functies van het elektronisch dossier vindt u het minst nuttig?

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3.23 Welke functies mist u in het elektronisch dossier?

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Voor- en nadelen papieren dossier

3.24 Welke voordelen ervaart u bij het gebruik van een papieren dossier?

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3.25 Welke nadelen ervaart u bij het gebruik van een papieren dossier?

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Gebruiksgemak

Graag het juiste antwoord aankruisen.

4.1	Het vinden van gegevens gaat bij een elektronisch dossier makkelijker dan in een papieren dossier.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.2	Het vastleggen van gegevens gaat bij een elektronisch dossier makkelijker dan in een papieren dossier.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.3	De indeling van de schermen van het elektronisch dossier sluit goed aan bij mijn werkwijze.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.4	Ik kan snel het juiste scherm / venster vinden.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.5	Ik kan de informatie goed lezen.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.6	De indeling van de schermen / vensters vind ik logisch.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.7	De opmaak en het kleurgebruik van de schermen vind ik prettig.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.8	Het is makkelijk gegevens op de juiste manier in te voeren.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.9	Het is makkelijk gegevens op te vragen.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.10	De gegevens worden op precies die manier gepresenteerd, die ik nodig heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.11	Ik kan de gegevens precies op die manier invoeren als ik nodig vind.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.12	Je wordt vanzelf handig in het gebruik van het elektronisch dossier.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.13	Er is weinig of geen training nodig om het elektronisch dossier te gaan gebruiken.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.14	Het is meteen duidelijk wat een bepaalde functie / scherm / knop inhoudt.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.15	Het is meteen duidelijk hoe een bepaalde functie / knop gebruikt moet worden.	eens ( ) ( ) ( ) ( ) ( ) oneens
4.16	Om gegevens in te voeren of op te vragen maak ik vooral gebruik van:	
	- toetsenbord	eens ( ) ( ) ( ) ( ) ( ) oneens
	- muis	eens ( ) ( ) ( ) ( ) ( ) oneens
	- anders	
	.....	
	.....	
4.17	Om gegevens in te voeren of op te vragen vind ik het	

prettigst in gebruik:

- toetsenbord — eens ( ) ( ) ( ) ( ) ( ) oneens
- muis — eens ( ) ( ) ( ) ( ) ( ) oneens
- anders .....

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Graag het juiste antwoord omcirkelen

4.18 Gebruikt u onderstaande mogelijkheden van het elektronisch dossier?

Personalisatie (d.w.z. het scherm aanpassen aan uw wensen)	Ja	Nee
Thuiswerken	Ja	Nee
Toegang via draadloze apparatuur (b.v. handheld computer, PDA, laptop)	Ja	Nee
Invoeren van gegevens via spraakherkenning	Ja	Nee
Gegevens dicteren en door secretaresse laten intypen	Ja	Nee
Gegevens opschrijven en door secretaresse laten intypen	Ja	Nee

4.19 Welke mogelijkheden van de schermen waardeert u het meest? (b.v. eigen patiëntenlijst, invulschermen met vinkjes, etc)

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Privacy

Graag het juiste antwoord aankruisen.

5.1	Een ongewenst effect van het gebruik van een elektronisch dossier is, dat anderen meer inzicht krijgen in mijn medisch handelen.	eens ( ) ( ) ( ) ( ) ( ) oneens
5.2	Omdat anderen inzage hebben in de door mij ingevoerde gegevens, ben ik zorgvuldiger bij het vastleggen van gegevens.	eens ( ) ( ) ( ) ( ) ( ) oneens
5.3	Omdat anderen inzage hebben in de door mij ingevoerde gegevens, leg ik meer gegevens vast.	eens ( ) ( ) ( ) ( ) ( ) oneens
5.4	Omdat anderen inzage hebben in de door mij ingevoerde gegevens, leg ik minder gegevens vast.	eens ( ) ( ) ( ) ( ) ( ) oneens
5.5	Het gebruik van het elektronisch dossier verhoogt de kwaliteit van de vastlegging van medische gegevens.	eens ( ) ( ) ( ) ( ) ( ) oneens

Besluitvorming

Graag het juiste antwoord aankruisen

6.1	Ik bepaal zelf of ik het elektronisch dossier gebruik of niet.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.2	Ik gebruik het elektronisch dossier, omdat de organisatie / maatschap / mijn collega's dat van mij verlangen.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.3	Ik gebruik naast het elektronisch dossier ook een papieren patiëntdossier.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.4	Als ik dat zou willen, kan ik besluiten het elektronisch dossier niet meer te gebruiken.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.5	Ik blijf het elektronisch dossier gebruiken, omdat ik al veel tijd geïnvesteerd heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.6	Ik blijf het elektronisch dossier gebruiken, omdat ik al veel geld geïnvesteerd heb.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.7	Ik blijf het elektronisch dossier gebruiken, omdat het goed bevalt.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.8	De voordelen van het gebruik van een elektronisch dossier wegen ruimschoots op tegen de nadelen.	eens ( ) ( ) ( ) ( ) ( ) oneens
6.9	Het gebruik van een elektronisch dossier heeft veel voordelen ten opzichte van het gebruik van een papieren dossier.	eens ( ) ( ) ( ) ( ) ( ) oneens

Hartelijk dank voor de genomen moeite.

U kunt de enquête in de antwoordenvelop retourneren of ongefrankeerd versturen naar

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Appendix D: Questionnaire Results

	Results questionnaire	*Number*	*Result*
	Number of filled out questionnaires	*9*	*100%*
	Internal Medicine (including Gastro-enterology)	*7*	*78%*
	Cardiology	*2*	*22%*
	Hospital A	*7*	*78%*
	Hospital B	*2*	*22%*
	Do you use the following computer-programs when performing your tasks?	*1 = Yes* *0 = No*	
1.1.a	- in the field of office - automation (e.g. Word, Excel)	*8*	*89%*
1.1.b	- Hospital Information System (HIS), e.g. Hiscom	*4*	*44%*
1.1.c	- financial system	*1*	*11%*
1.1.d	- electronic patient record (e.g. Norma or MCS)	*8*	*89%*
1.1.e	- other: medical viewer	*1*	*11%*
1.2.	*Do you use the following functions of the Electronic Patient Record/*		
1.2.a	DBC-registration	*8*	*89%*
1.2.b	Management information for your own fellowship	*1,5*	*17%*
1.2.d	Composing discharge- and other letters	*6*	*67%*
1.2.e	Make appointments	*2*	*22%*
1.2.f	Complication-registration	*5*	*56%*
1.2.g	Coding-lists	*3*	*33%*
	Documentation of :		
1.2.h	- medical history	*6*	*67%*
1.2.i	- physical examination	*6*	*67%*
1.2.j	- differential diagnosis	*6*	*67%*
1.2.k	- policy	*6*	*67%*
1.2.l	- proposed examination	*6*	*67%*
1.2.m	- proposed therapy	*6*	*67%*
1.2.n	- decursus	*6*	*67%*
1.2.o	- treatment-plan	*6*	*67%*
	Documentation of investigation performed by you:		
1.2.t	- endoscopy images	*2*	*22%*
1.2.u	- endoscopy reports	*4*	*44%*
1.2.v	- ultra sound images	*1*	*11%*
1.2.w	- ultra sound reports	*1*	*11%*
1.2.x	- other: *open question, answers in left column, frequencies on the right*		
	sternal punctations	*1*	*11%*
	snapshot of patients	*1*	*11%*
	digital pictures of abnormalities	*1*	*11%*
	scan of investigation performed elsewhere, e.g. kidney-biopsy	*1*	*11%*
	echocardiogram	*1*	*11%*
	heart-catheterisation	*1*	*11%*

	Purposes of the Electronic Patient Record	*1 = fully disagree* *5 = fully agree*	
2.1.	The patient data entered by me, do I use to perform my medical tasks	*4,4*	*agree*
2.2.	The patient data entered by me, are used by my colleagues or other care providers to perform their medical tasks	*4,0*	*agree*
2.3.	The patient data entered by me, serve as an order to other care providers.	*2,3*	*disagree*
2.4.	The patient data entered by me are used for billing.	*2,0*	*disagree*
2.5.	The electronic recording of patient data has also the purpose of accounting for my medical acting towards the patient.	*3,9*	*agree*
2.6.	The electronic recording of patient data has also the purpose of accounting for my medical acting legally.	*4,1*	*agree*
2.7.	The electronic recording of patient data has also the purpose of fulfilling legal obligations.	*3,2*	*neutral*
2.8.	The electronic recording of patient data has also the purpose of fulfilling national and other registrations.	*3,2*	*neutral*
2.9.	The electronic recording of patient data has also the purpose of giving me insight in the managing of my medical practice.	*2,6*	*neutral*
2.10.	The electronic recording of patient data is also used by the hospital-organization for management purposes.	*2,4*	*disagree*
2.11.	I use the electronic recording of patient data to evaluate my medical acting.	*2,9*	*neutral*
2.12.	The electronic recording of patient data is used to evaluate the medical acting of my colleagues and me.	*2,9*	*neutral*
31.	With the aid of the electronic record I can perform my tasks faster.	*3,1*	*neutral*
3.2.	With the aid of the electronic record I can perform my tasks better.	*3,2*	*neutral*
3.3.	The times spent on a complete medical process for a patient is shorter thanks to the electronic record	*2,2*	*disagree*
3.4.	I can spend more time on direct patient care thanks to the electronic record.	*1,7*	*disagree*
3.5.	With the aid of the electronic record I can perform my tasks easier.	*2,9*	*neutral*
3.6.	I find the electronic record useful for my job.	*4,2*	*agree*
3.7.	I don't want to do without the electronic record anymore.	*3,6*	*agree*
3.8.	The electronic record exactly shows the information I need.	*3,2*	*neutral*
3.9.	The electronic record exactly offers the functions I need.	*3,0*	*neutral*
3.10.	The electronic record does not have redundant functions.	*2,7*	*neutral*
3.11.	The electronic record contains all the information I need.	*3,0*	*neutral*
3.12.	The electronic record has all the functions I need.	*2,7*	*neutral*
3.13.	The electronic record does not have redundant information.	*2,6*	*neutral*
3.14.	In the electronic record I can document all the information I want.	*2,9*	*neutral*
3.15.	At the moment I need specific information it is available to me.	*3,5*	*agree*
3.16.	At the moment I need specific functions it is available to me.	*3,6*	*agree*
3.17.	At any location where I need specific information it is available to me.	*4,6*	*agree*
3.18.	At any location where I need specific functions it is available to me.	*3,7*	*agree*
3.23	What functions do you miss in the electronic record? *open question, answers in left column, frequencies on the right*		
	none or I don't know	*2*	*22%*
	endoscopy images	*1*	*11%*
	notification manager	*1*	*11%*
	communication … from medication overviews	*1*	*11%*
	overview of microbiology reports	*1*	*11%*
	flipping through the record is not so easy	*1*	*11%*
	data analysis	*1*	*11%*

	adequate statistics is not possible	*1*	*11%*
	link with other databases	*1*	*11%*
	speech recognition	*1*	*11%*
	PACS / images	*1*	*11%*
	Ease of use	*1 = fully disagree* *5 = fully agree*	
4.1.	Finding data is easier in an electronic record than in a paper record.	*3,8*	*agree*
4.2.	Documenting data is easier in an electronic record than in a paper record.	*2,9*	*neutral*
4.3.	The ordering and design of windows fits very well with the way I work.	*2,7*	*neutral*
4.4.	I can easily find the right window.	*3,0*	*neutral*
4.5.	I can read the information well.	*3,9*	*agree*
4.6.	I find the ordering and design of the windows logical.	*3,1*	*neutral*
4.7.	I like the lay-out and colors of the windows.	*3,4*	*neutral*
4.8.	It is easy to enter the data in the right way.	*2,9*	*neutral*
4.9.	It is easy to retrieve data.	*2,9*	*neutral*
4.10.	The presentation of the information exactly fits what I need.	*3,1*	*neutral*
4.11.	I can enter the data exactly the way I need.	*3,1*	*neutral*
4.12.	You get skilled automatically when using the system.	*4,2*	*agree*
4.13.	Little or no training is needed to start using the system.	*2,8*	*neutral*
4.14.	The meaning of a function, window or button is immediately clear.	*2,9*	*neutral*
4.15.	The use of a function or button is immediately clear.	*2,8*	*neutral*
4.16.	To enter data I usually use the		
4.16.a	- keyboard	*3,8*	*agree*
4.16.b	- mouse	*4,0*	*agree*
4.17.	For data entry I prefer to use the		
4.17.a	- keyboard	*2,8*	*neutral*
4.17.b	- mouse	*3,6*	*agree*
4.17.c	- other *open question, answers in left column, frequencies on the right*		
	voice recognition	*1*	*11%*
4.18.	Do you use the following functions of the electronic record?	*1 = Yes* *0 = No*	
4.18.a	Personalisation (i.e. adjusting the windows to your preferences)	*2*	*22%*
4.18.e	Dictating data followed by typing by a secretary	*2*	*22%*
4.18.f	Writing down data followed by typing by a secretary	*0*	*0%*
4.19	What possibilities of the windows do you appreciate most? *open question, answers in left column, frequencies on the right*		
	diversity	*1*	*11%*
	list of appointments	*1*	*11%*
	don't know yet	*1*	*11%*
	list of patients	*2*	*22%*
	Privacy of doctor	*1 = fully disagree* *5 = fully agree*	
5.1.	An undesirable effect of the use of an electronic record is, that others get more insight in the way I work.	*2,4*	*disagree*
5.2.	I am more careful in documenting data, because others can see the data documented by me.	*4,0*	*agree*
5.3.	I document more data, because others can see the data documented by me.	*2,8*	*neutral*
5.4.	I document less data, because others can see the data documented by me.	*2,3*	*disagree*

5.5.	The use of an electronic record improves the quality of documentation of medical data	*3,7*	*agree*
	Decision making		
6.1.	I decide whether I use the electronic record or not.	*2,1*	*disagree*
6.2.	I use the electronic record because the organization / the fellowship / my colleagues demand so.	*3,0*	*neutral*
6.3.	I also use a paper record.	*2,6*	*neutral*
6.4.	If I would like to, I can decide not to use the electronic record anymore.	*1,8*	*disagree*
6.5.	I continue to use the electronic record, because I already invested a lot of time.	*3,3*	*neutral*
6.6.	I continue to use the electronic record, because I already invested a lot of money.	*2,0*	*disagree*
6.7.	I continue to use the electronic record, because it suits me.	*3,8*	*agree*
6.8.	The advantages of the electronic record outweigh the disadvantages.	*3,7*	*agree*
6.9.	The use of an electronic record has many advantages compared to the use of a paper record.	*3,9*	*agree*

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