IMPROVING HEALTHCARE
INFORMATION SYSTEMS - A KEY
TO EVIDENCE BASED MEDICINE
LICENTIATE DISSERTATION

IMPROVING HEALTHCARE INFORMATION SYSTEMS - A KEY TO EVIDENCE BASED MEDICINE

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ABSTRACT

Delivering good quality care is a complex endeavor that is highly dependent on patient information and medical knowledge. When decisions about the care of a patient are made, they must, as far as possible, be based on research-derived evidence rather than on clinical skills and experience alone. Evidence based medicine (EBM) is the conscientious and judicious use of current best evidence in conjunction with clinical expertise as well as patient values and preferences to guide healthcare decisions. Following the principles of EBM, healthcare practitioners are required to formulate questions based on patients’ current clinical status, medical history, values and preferences, search the literature for answers, evaluate the evidence for its validity and usefulness, and finally apply the information to the patient. Information systems play a crucial role in the practice of evidence based medicine, by allowing healthcare practitioners to access clinical evidence and information about the patients’ health as they formulate their patient-care strategies. However, current information systems solutions are far from this perspective for various reasons. One of these reasons is that existing information systems do not support a seamless flow of patient information along the patient process. Due to interoperability issues, healthcare practitioners cannot easily exchange patient information from one information system to another and from one healthcare practitioner to another. Consequently, vital information that is stored in separate information systems and which could present a clear and complete picture of the patient cannot be easily accessed. All too often, units have to operate without knowledge of the problems addressed by other healthcare practitioners from other units, the services provided, medications prescribed, or preferences expressed in those previous situations. The practice of EBM is further complicated by current information systems that do not support practitioners in their search and evaluation of current evidence in everyday clinical care.

Based on a qualitative approach, this work aims to find solutions for how future healthcare information systems can support the practice of EBM. By combining existing research on process orientation, knowledge management and evidence based medicine with empirical data, a number of recommendations have been initiated. These recommendations aim to support healthcare managers, IT-managers and system developers in the development of future healthcare information systems, from a process-oriented and knowledge management perspective. By following these recommendations, it is possible to develop information systems that facilitate the practice of evidence based medicine, and improve patient engagement.
SAMMANFATTNING

Alla patienter har rätt till en god och säker vård. Tillgången till patientinformation och medicinsk kunskap är därför en nyckelfråga för att skapa förutsättningar för en sådan vård. Beslut om behandling och vård skall så långt som möjligt baseras på bästa möjliga kunskap. Evidensbaserad medicin (EBM) innebär att beslut i den kliniska situationen baseras på en kombination av senaste vetenskapliga evidens i kombination med vårdgivarens expertis och patientens preferenser.

Att basera beslut på vetenskap och beprövade erfarenheter har dock visat sig svårt för vårdpersonalen. Det beror bland annat på att de har begränsad tillgång till informationssystem som stödjer en snabb och enkel tillgång till patientinformation över organisationsgränserna. Tillgång till relevant information är en nödvändighet för att kunna garantera en god och säker vård. Ytterligare en anledning är att befintliga informationssystem inte stödjer vårdpersonalen till att enkelt hitta, sovra och använda vetenskaplig kunskap i vården.

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PUBLICATIONS

Publications written as part of this thesis are listed below. Paper 1, 3 and 5 were published prior to name change.

PUBLICATIONS WITH HIGH RELEVANCE


## CONTENTS

1. INTRODUCTION ........................................................................................................ 1
   1.1 Healthcare Information systems - challenges .................................................. 3
       1.1.1 Research problem ................................................................................. 4
   1.2 Research questions ......................................................................................... 7
   1.3 Delimitations .................................................................................................. 8
   1.4 Thesis structure ............................................................................................. 8

2. THEORETICAL BACKGROUND ............................................................................ 11
   2.1 Evidence based medicine ............................................................................. 11
   2.2 Process orientation in healthcare ................................................................. 12
   2.3 Patient process ............................................................................................. 16
   2.4 Basic concepts of knowledge management ................................................. 17
   2.5 Definition of knowledge management ......................................................... 18
   2.6 Is healthcare in need of knowledge management ......................................... 22
   2.7 Knowledge management and organizational processes ............................. 23
   2.8 The relationship between EBM, process orientation and KM ..................... 26
   2.9 Related Research ......................................................................................... 27

3. RESEARCH METHOD ........................................................................................... 29
   3.1 Approaches to research ................................................................................ 29
   3.2 Research process .......................................................................................... 30
       3.2.1 Literature review .................................................................................. 31
       3.2.2 Case study research ........................................................................... 32
   3.3 Case study one .............................................................................................. 33
       3.3.1 Interviews, observations and process modeling ................................... 33
       3.3.2 Prototype development ...................................................................... 36
   3.4 Case study two .............................................................................................. 37
       3.4.1 Interviews ............................................................................................ 38
   3.5 Qualitative analysis ....................................................................................... 41
   3.6 Good research practice ................................................................................ 42
   3.7 The trustworthiness of the research ............................................................... 43
       3.7.1 Credibility ............................................................................................ 43
       3.7.2 Dependability ...................................................................................... 44
       3.7.3 Transferability ..................................................................................... 44
       3.7.4 Conformability ................................................................................... 44

4. RESULTS ................................................................................................................ 45
4.1 Patients’ experiences of communicating with healthcare - An information exchange perspective ............................................................ 46
4.2 Challenges and opportunities with information system support for healthcare processes – A healthcare practitioner perspective ......................................................... 46
4.3 Web-based knowledge portals in Swedish healthcare – Overview and challenges ...................................................................................... 48
4.5 Worlds apart – IT strategies for evidence based medicine meets reality ...... 49
4.6 Supporting active patient and healthcare collaboration - A prototype for future healthcare information systems .......................................................... 50
4.7 Supporting evidence based medicine – A prototype for future healthcare information systems ................................................................... 51

5. SYNTHESIZED RESULTS ........................................................................... 53
5.1 Future IS should support the principles of evidence based medicine ................ 53
5.1.1 A process-oriented approach, with supporting information systems ... 53
5.1.2 Improve patient engagement through process-oriented information systems ........................................................................................................ 54
5.1.3 Offer not only current information, but also relevant information according to the patient process ......................................................... 55
5.1.4 Future information system should enable a combination of access, communication, creation and capture of medical knowledge ............... 55

6. CONCLUDING REMARKS AND FUTURE WORK ............................................. 57
6.1 Revisiting the research questions .............................................................. 57
6.2 Contributions ................................................................................................ 59
6.2.1 Summary of knowledge contributions ................................................. 59
6.3 Future work ................................................................................................ 61

7. APPENDIX ...................................................................................................... 63
7.1 Appendix 1: Interview guide – Case study one .............................................. 63
7.2 Appendix 2: Interview guide – Case study two (study one) ......................... 65
7.3 Appendix 3: Interview guide – Case study two (study two) ......................... 66

8. REFERENCES .................................................................................................. 73
Delivering good quality care is a complex endeavor that is highly dependent on patient information and medical knowledge (Bose, 2003; Rezazadeh et al., 2014). When decisions about the care of a patient are made, they must, as far as possible, be based on research-derived evidence rather than on clinical skills and experience alone. Evidence based medicine (EBM) is the conscientious and judicious use of current best medical evidence in conjunction with clinical expertise as well as patient values and preferences to guide healthcare decisions, see figure 1.1 (Sackett et al., 1996; Sackett et al., 2000). Clinical expertise refers to the practitioner’s cumulated experience, education and clinical skills that the individual acquires through clinical experience and clinical practice. The patient brings to the encounter his or her own personal preferences and unique concerns, expectations, and values that must be considered. The best medical evidence, also called medical knowledge, is usually found in medical guidelines, systematic reviews and other clinically relevant medical research that has been conducted using sound methodology (Sackett et al., 2000). The purpose of EBM is to provide a stronger scientific foundation for clinical work, in order to achieve consistency, quality, and safety in care (Timmermans & Mauck, 2005). The evidence based medical knowledge does not, by itself, make the decision, but it can help support the practitioner in the decision-making. Following the principles of EBM, practitioners are required to formulate clinical questions based on the understanding of the patient’s clinical condition. The patient’s condition can be understood by the past and present diagnosis, as well as laboratory and administrative data (El-Gayar & Timsina, 2014). After the patient’s condition has been identified and synthesized into clinical questions, the practitioner proceeds with the search of the literature for answers, evaluates the evidence for its validity and usefulness, and finally applies the information to patients (Lenz & Reichert, 2007; Mayer, 2009). The degree to which the clinician can practice EBM is thus dependent upon the availability of information about the patient (such as diagnosis, prognosis and therapy) and medical knowledge (such as medical guidelines). Patient information is a precondition for medical decisions and it is evidence based medical knowledge, clinical expertise as well as patient values and preferences that guide these decisions. The full integration of these components into clinical decisions enhances the opportunity for improved quality and safety of care.
Nevertheless, practicing EBM is challenging. One reason is the lack of information systems (IS) that support a seamless flow of patient information (both medical and administrative information) along the care process. This is highly disturbing, since the traditional single, doctor-patient relationship is increasingly being replaced by one in which the patient is managed by a team of healthcare practitioners, each specializing in one aspect of care (Bose, 2003, p. 61). Such seamless and shared care critically depends on collaboration and the ability to easily share information between healthcare providers (Iroju et al., 2013; Bose, 2003). Collaboration between healthcare providers and the patient is also essential in ensuring the proper delivery of the most appropriate care, since both parties share vital information. The healthcare practitioner offers evidence based treatment options, as well as their risks and benefits, while the patient offers his/her experience of the medical condition, values and expectations (Oshima Lee & Emanuel, 2013). Considering and incorporating the values, preferences, needs and experiences of patients in, e.g., treatment plans are important for the practice of EBM and crucial for the engagement of the patient in the decision-making.

EBM is also almost impossible to practice in the everyday clinical care, as healthcare practitioners typically do not have the time to carry out literature research while the patient is in the office. Therefore, literature searches will necessarily take place offline (Lenz & Reichert, 2007). Those practitioners who search for medical knowledge during the patient encounter all too often find that existing knowledge may not necessarily correspond to the issue at hand (Clancy & Cronin, 2005). Some healthcare practitioners may even decide not to actively look for the required medical knowledge because existing information systems are not adequate enough to answer the clinical questions that arise. This raises the questions whether patient information and medical knowledge can be provided in a more compact and applicable form and whether information technology (IT) can improve the practice of EBM. In order to find appropriate answers to these questions, it is important to initially understand the characteristics of the healthcare organization.
1.1 HEALTHCARE INFORMATION SYSTEMS - CHALLENGES

Traditionally, the healthcare organization has a functional organizational structure employing several thousand healthcare practitioners working in professional, functional and geographic groups. Each group has, according to Ben-Tovim et al. (2008), an internal, usually hierarchical, structure, and orientates its work by the views held within its dominant professional or organizational membership. Groups cherish their autonomy, which means that, e.g., orthopedic surgeons or orthopedic units view the world from their orthopedic perspective. Therefore, they only see and take responsibility for their specific part of the care process. Patients, however, move horizontally across organizational units. This journey, also called the patient process, takes the patient from unit to unit, where he/she receives care from different healthcare practitioners. Since healthcare practitioners only see and take responsibility for their particular component, no one (except the patient) has an overview of the whole patient process. Therefore, poor coordination of the patient’s care is common (Ben-Tovim et al., 2008).

The functional organizational structure has influenced how healthcare information systems have been developed. A common scene within most hospitals and primary healthcare centers is the distribution of patient information along several departmental information systems (see figure 1.2). As a result, patient information is organized and managed by several autonomous information systems, which contribute to the emergence of so-called islands of information. These information systems have been developed at widely differing points in time, by using different development paradigms as well as different software and hardware platforms. Therefore, current healthcare information systems suffer from a number of problems:

- They support single organizational units very well, but have trouble exchanging information between care units and between care providers and the community at large, e.g., social insurance offices, resulting in poor inter-organizational communication and collaboration (Ministry of Health and Social Affairs, 2006; Perjons et al., 2005).
- Electronic healthcare records (EHRs) have traditionally been developed mainly for managing patient information (Berg, 2001a). They have also been developed separately from general medical knowledge. Therefore, knowledge, such as medical guidelines, is to a larger extent not integrated into EHRs. Instead, this knowledge is stored in numerous autonomous IT-based knowledge repositories at different levels (local, regional, national). Finding relevant medical knowledge is therefore difficult (Rexhepi & Persson, 2013).
- They do not facilitate work activities. These activities, which may be helped by computerization are performed manually, and consume 50 to 80 percent of the physician’s time (Perjons et al., 2005).
- They lack established common user interfaces, making them difficult to navigate and use. Lack of “ease of use” prevents healthcare practitioners from achieving specified goals with effectiveness, efficiency, and satisfaction (Berg, 2001a; Ministry of Health and Social Affairs, 2006).
- They cannot easily compile and communicate information to accounting and management systems at executive and principal levels, or to national registers, such as health data and quality registers (Ministry of Health and Social Affairs, 2006).
- They do not facilitate patient engagement. Patients themselves cannot easily access information about their care. Electronic communication with healthcare practitioners and the electronic booking of treatments and examinations is also limited (Ministry of Health and Social Affairs, 2006). Studies have shown that giving patients more access to their health information can encourage them to participate in their own care, self-manage their health condition, increase understanding of their medical issues, and improve patient–provider communication (Ricciardi et al., 2013; Delbanco et al., 2012).

Since decisions about the care of individual patients must be made by interpreting patient specific information according to relevant medical knowledge, sharing and accessing both patient information and medical knowledge is crucial, in order to avoid medical errors, improve diagnoses, avoid re-admissions and decrease duplicate testing. Despite this extensive knowledge, the current fragmented system of healthcare that misses information and knowledge, and lacks coordination is resulting in health-related injuries, low quality care and wasted resources (Iroju et al, 2013; Perjons et al., 2005).

1.1.1 RESEARCH PROBLEM
Healthcare processes are characterized by a high degree of communication and cooperation among physicians, nurses, and other groups of practitioners (Lenz, et al., 2002; Lenz &Reichert, 2007) who participate in the care of the patient. For example, a frail elderly person who sustains a hip fracture may require treatment from an orthopedic surgeon, hospital nurses, hospital physical therapist, home care nurses, home care physical therapists, a primary care physician and a primary care nurse. Each of these actors generates information that is needed by the others. In making decisions about patient care, healthcare practitioners frequently raise questions in their practice. Although they are effective in finding answers to questions they pursue, roughly half of the questions are never answered (Del Fiol, Workman & Gorman, 2014), due to the lack of patient information and medical knowledge. On this basis, it is almost impossible to practice EBM in everyday clinical care.
Information systems play a crucial role in the practice of evidence-based medicine, by allowing healthcare practitioners to access clinical evidence and information about the patients’ health, as they formulate their patient-care strategies (Wells, 2007; Del Fiol, Workman & Gorman, 2014). However, current healthcare information systems are not meeting the expectations and rarely fulfill these requirements (Lenz et al., 2002; Iroju et al., 2013) (see figure 1.3). Due to interoperability issues, healthcare practitioners cannot easily exchange patient information from one information system to another and from one healthcare practitioner to another. Consequently, vital information that is stored in separate information systems cannot be easily accessed, in order to present a clear and complete picture of the patient. All too often, units have to operate without knowledge of the problems addressed by other healthcare practitioners from another unit, including services provided, medications prescribed, or preferences expressed in the previous healthcare setting (Ben-Tovim et al., 2008). Medical procedures may become impossible to perform, if information is missing, preparations have been omitted, or a preceding procedure has been postponed, canceled or requires latency time. Depending procedures may then have to be re-scheduled resulting in numerous phone-calls and time losses. If any results are missing but urgently needed, tests or procedures may have to be performed repeatedly (Reichert, 2011, p. 5; Tan, 2005). In the absence of this information, a complex set of patient flows emerges in which a patient’s medical records, necessary for care, have to be printed and transmitted between and across units, which often leads to a high administrative load for practitioners and, in the case of emergency care, lifesaving information may be unavailable (Reichert, 2011; Lenz & Reichert, 2007). The printed copies of the medical record must then be integrated into the recipient’s EHR, by adding a scanned version to the system or typing a summary in the system. This can entail problems related to inefficiency and the risk of making errors (Zwaanswijk et al., 2011). The patient is also an important link in the transfer of information between different healthcare providers. In the majority of care situations, the patient is the only common component between units and, by default, the patient is given the added responsibility of communicating his/her patient information, both medical (e.g., medical notes, laboratory tests, diagnostic imaging reports, treatments, therapies, medical list, allergies and x-rays) and administrative (e.g., appointments) between healthcare providers. Consequently, patients often experience one or more omissions in the information exchange. Common omissions that must be filled by the patient include: recounting medical history, because the healthcare provider has not received the records from another provider, or having to bring the test results to an appointment (Patel, Barker & Siminerio, 2014). When patients have to recount their medical history, it can negatively affect the quality of care, especially if the patient does not want to disclose certain information or communicates incorrect information. Despite the fact that patients take a great responsibility in communicating information between different units, they are not actively engaged in their own care. For example, they do not have quick and trouble-free access to all-round information about their personal health status. Much of the patient’s time is therefore spent on locating and communicating information between healthcare practitioners. Electronic booking of an appointment is also limited. The situation is further complicated, as electronic communication between patients and care services is limited. Given that collaboration between care providers and patients is essential in ensuring the proper delivery of appropriate care for patients, the situation is not optimal.

As a consequence of the functional organizational structure with its associated autonomous information systems, healthcare practitioners usually fail to communicate critical elements of the care to the receiving unit. Bottlenecks may even occur when one unit sends a patient to another unit that is not ready to take care of the patient (Vos et al., 2011; Zwaanswijk et al., 2011). In some cases, the patient may not even be adequately prepared for care in the next unit, due to lack of coordination between units. The functional structure slows the de-
cision-making, makes work coordination difficult, and inhibits communication, since each unit “looks after their own interest, without realizing how their activities affect others or the patient (Dunham-Taylor & Pinczuk, 2006).

In making decisions about patient care, healthcare practitioners must also use current best evidence (explicit/documentated medical knowledge) in conjunction with clinical expertise (tacit knowledge). Despite the broad availability of online evidence resources that can help answer questions raised by healthcare practitioners, many of them remain unanswered (Del Fiol, Workman & Gorman, 2014). Some healthcare practitioners do not even try to search for the needed medical knowledge, because textbooks, journals, and existing information systems are not adequate for answering the clinical questions that arise. Textbooks may be out of date, information in journals is too difficult, if not impossible, to translate into daily work practice and current information systems solutions, such as IT-based knowledge repositories, are not widely used because they are: (1) not comprehensive, (2) not integrated within EHRs, (3) information in the repository is not structured and therefore difficult to grasp, and (4) most of the IT-based knowledge repositories do not facilitate the sharing of experience-based clinical knowledge. Given the situation, it is not surprising that healthcare practitioners lack the time for such research while the patient is in the office. Since relevant medical knowledge is usually not available at the time decisions are made, healthcare practitioners must rely on experience and consultation with seniors, rather than on best scientific medical evidence.

EBM thus requires the efficient exchange of and access to patient information and medical knowledge. Questions that cannot be answered because valuable information and knowledge is missing may lead to suboptimal patient-care decisions. In critical situations, lack of patient information and medical knowledge may even lead to late or wrong decisions (Reichert, 2011; McClellan et al., 2008; Del Fiol, Workman & Gorman, 2014). Lack of information can also result in a high administrative load for practitioners, increased healthcare costs, longer than required hospital stays and, most seriously, declining quality of patient care (Iroju et al, 2013). Studies have shown that physicians and nurses are aware of these problems and that an information system which provides quick and easy access to
up-to-date patient information and relevant medical knowledge in the context of patient care decision-making is highly welcome. In an increasing way it is being understood that correlation between medicine, organization and information is high, and that current functional organizational structures and healthcare information systems offer sub-optimal support.

1.2 RESEARCH QUESTIONS

Improving quality and safety in healthcare requires that a variety of medical knowledge and information about the patient is made available to healthcare practitioners when and where it is needed. Therefore, this thesis aims to find solutions for how future healthcare information systems can support the practice of EBM, by improving the availability of patient information (both medical and administrative information) and medical knowledge in a way which can be seamlessly integrated with healthcare practitioners‘ work practice. Since safety and quality of care are strongly related to patient engagement, this thesis also aims to find solutions to how patient engagement can be enhanced through improved provider-patient communication. Given this aim, the main research questions are (see figure 1.4):

1. **What are the problems with the availability of up-to-date patient information, from the perspective of patients?**
   Patients today have a growing desire to take greater control over their personal health through access to their healthcare information. Patients’ access to their health information is a precondition for enabling patient engagement. Since patient engagement is essential for improving quality and safety of care, this research question aims to increase knowledge regarding how patients in Sweden experience the exchange of information with healthcare providers.

2. **What are the problems with the availability of up-to-date patient information and relevant medical knowledge when and where it is needed, from the perspective of healthcare practitioners?**
   This question aims to identify the challenges that healthcare practitioners perceive with regard to availability of patient information and medical knowledge, when making decisions about the care of individual patients. It also aims to identify requirements for how information systems should support a seamless flow of information and knowledge along the patient processes.

3. **How can healthcare information systems support the availability of up-to-date patient information and relevant medical knowledge in a way which can be seamlessly integrated with healthcare practitioners’ work practice?**
   Based on the challenges and requirements identified in research questions 1 and 2, this question aims to demonstrate, by using a prototype development, how healthcare information systems can support the availability of up-to-date patient information and relevant medical knowledge in a way which can be seamlessly integrated with healthcare practitioners‘ work practice. The prototype is used to visualize the solutions to the challenges/problems identified in research question 2.

4. **How can healthcare information systems support patient engagement through improved provider-patient communication?**
   Similar to research question 3, this question aims to demonstrate how healthcare information systems can improve patient engagement. The prototype that is used in re-
search question 3 will also be used for this question in order to demonstrate how information systems can support active involvement of patients in their own healthcare.

5. What recommendations can be initiated for the development of future information systems that (1) support healthcare practitioners’ access to up-to-date patient information and relevant medical knowledge in a way which can be seamlessly integrated with their work practice and (2) improve patient engagement?

In addition to the prototype, a number of recommendations for the development of healthcare information systems are given. These recommendations are based on the findings from research questions 1, 2, 3 and 4.

![Figure 1.4: The research design in respect to research questions, objectives and research papers](image)

1.3 DELIMITATIONS

Developers of healthcare information systems around the world endeavor to increase the quality of care by improving the availability of patient information and relevant medical knowledge. However, healthcare organizations, both nationally and internationally, are still characterized by an increasing number of medical disciplines and specialized units comprising diverse autonomous information systems. Although problems with autonomous information systems are found in other countries, this work focuses on the Swedish healthcare system. The delimitation derives primarily from the fact that acts and regulations governing the storage and dissemination of information may vary between countries.

1.4 THESIS STRUCTURE

The thesis is composed of six chapters. Chapter 1 introduces the research area and research problem, followed by a presentation of the research questions. It discusses the problems facing the healthcare sector, with regard to information system support. The theoretical background chapter (Chapter 2) provides an overview of the main theories used, and how
they relate to each other. This chapter concludes with a presentation of related research. The methodology chapter (Chapter 3) presents the main method and data collection techniques used. It discusses the research approach applied to the research presented in this thesis and is followed by a presentation of the research process. The chapter concludes with reflections on the trustworthiness of the research.

Chapter 4 provides a brief summary of each research paper, focusing on aims and conclusions drawn. A synthesis of the results is given in chapter 5. The synthesis is based on a number of recommendations for the development of future healthcare information systems. The major findings of the research are concluded in chapter 6. Moreover, chapter 6 outlines the research contributions and presents suggestions for future work.
CHAPTER 2
THEORETICAL BACKGROUND

This chapter introduces and defines the main concepts and theories used in this thesis, namely, EBM, Process Orientation and Knowledge Management (KM). When the definitions of the concepts and theories have been given, the chapter continues with the description of how EBM, process orientation and KM are interrelated. The chapter concludes with a presentation of related research.

2.1 EVIDENCE BASED MEDICINE

There are various definitions of evidence based medicine. A common denominator is the use of current best evidence in making decisions about the care of individual patients. The purpose of EBM is to improve quality, efficiency, and safety in care, through the provision of a stronger scientific foundation for clinical work (Timmermans & Mauck, 2005). The most common definition of EBM is that of Sackett et al., (1996);

EBM is "the conscientious and judicious use of current best evidence in conjunction with clinical expertise and patient values to guide health [and social] care decisions"
(Sackett et al., 1996, p. 71).

The definition emphasizes that EBM requires integration of 1) individual clinical expertise, 2) patients’ values and preferences as well as 3) the best current evidence in the decision-making for patient care. The integration requires healthcare practitioners to be careful and thorough in what they do (named conscientious in the definition), and to use good judgment and common sense (named judicious in the definition). Individual clinical expertise refers to the practitioners’ proficiency and judgment acquired through their clinical experience and clinical practice. Best current evidence, means clinically relevant research. This research is, according to Sackett, Rosenberg, Gray, Haynes and Richardson (1996), based on the fundamental sciences of medicine and on patient-centered clinical research. In order to work according to EBM, practitioners must use both individual expertise and the best current evidence, together with the wishes, values and preferences of the patient, and neither one alone is enough (Sackett et al., 1996: Aveyard & Sharp 2013). Sackett et al., (1996) emphasize that a lack of clinical expertise may lead to practice that becomes tyrannized by evidence and without best current evidence there is a risk that practice becomes out of date.
Dawes et al., (2005) offer a similar, yet more holistic definition of EBM, by emphasizing the importance of the practitioners’ explicit and tacit knowledge. EBM, according to the authors, “requires that decisions about health and social care are based on the best available, current, valid, and relevant evidence. These decisions should be made by those receiving care, informed by the tacit and explicit knowledge of those providing care, within the context of available resources”. A different definition of EBM is given by the Swedish National Board of Health and Welfare (2014):

“EBM is based on the best clinical evidence from systematic research. Healthcare practitioners must have good clinical knowledge and skill to be able to determine if the guidelines match the patient’s health condition, clinical status and preferences”.

Unlike the other definitions presented in the aforementioned, the definition by the Swedish National Board of Health and Welfare (2014) not only emphasizes a patient’s preferences, but also the health condition and the clinical status of the patient, which indicates that healthcare practitioners must have access to the patient’s medical history when making decisions about the care of individual patients.

The foremost reason for using EBM is thus to improve the patient care delivery. Studies have shown that when practitioners have access to patient information and scientific medical knowledge at the point of care, it changes their patient care management decisions. However, as also discussed in previous sections, practicing EBM is difficult.

### 2.2 PROCESS ORIENTATION IN HEALTHCARE

Processes are the means by which organizations create value for their customers. “Processes are at the very heart of every enterprise”, claim Hammer and Stanton (1995, p. 4). Yet, in healthcare, processes are fragmented across many organizational units. They are effectively invisible and essentially unmanaged. In definitional terms, a process is a “structured, measured set of activities across time and place, with a beginning, an end, designed to produce a specified output for a particular customer or market” (Davenport, 1993, p. 5). A similar process definition is that of Harrington (1991), which focuses on how input is converted to results. Deming (1993) extends the definition by also including who does what. This gives a broader perspective that can be useful when making improvement efforts.

Moreover, Hammer and Stanton (1995) discuss processes as a group of related tasks that together create value for a customer. The interrelated work tasks are initiated in response to an event that achieves a specific result for the customer of the process. The definition by Hammer and Stanton (1995) emphasizes one of the important characteristics of a process, namely, the customers who are the recipients of the defined outcomes of the process. A similar definition is presented by the Swedish National Board of Health and Welfare (2010), Hammer and Champy (1993), Reijers (2006) and Harrington (1991), who define processes as a collection of activities that take one or more kinds of input and create an output that is of value to an internal or external customer. This definition puts emphasis on the input and output behavior of a business process that should result in some value to the customer. The definition of the process as “a collection of activities” is however abstract, since it neither implies the ordering of activities nor does it provide any other explanation for how the activities in the process are executed (Weske, 2007). However, in the aforementioned definition of business process by Davenport (1993), the relationship of process activities is emphasized and considered, since the term “activities across time and place” is used. Another slightly different definition of a process that is embraced in this work is given by Rentzhog (1998). He argues that a process is a “chain of interrelated activities that in
a recurrent flow creates value for a customer”. Processes have, according to Rentzhog (1998), five important characteristics (see figure 2.1):

- Interrelated activities: a group of related tasks that together create value for a customer.
- Recurrent flow: activities in a process are recurrent.
- Customer perspective: the aim of an organizational process is to deliver value to the customer. Therefore, organizations must adapt its processes to the customers and their wishes.
- Focus on results: the results of the process must be of value for the customer. Results/outcomes from the process may be a physical product or a service, e.g., providing good quality care.
- Feedback: processes need to be continuously evaluated and improved. Therefore, feedback on how well the organization has managed to meet customers’ wishes is important.

Additionally, processes have three important objects; (1) input to a process, which could be a patient referral, (2) a process uses resources, such as an information system, information, knowledge, medical tools, etc., transforms inputs into valuable outputs, e.g., based on the referral, carry out a patient encounter that leads to therapy. Furthermore, there are (3) regulations, rules and recommendations for how things should be done in a process, such as diverse medical guidelines, recommendations and clinical pathways that control how activities should be performed within a process (see figure 2.1).

![Figure 2.1: Five important characteristics of a process](image)

Moreover, processes can be divided or categorized with respect to their function in an organization. An organization’s primary processes, also called core processes, consist of the broadly-defined set of processes that together meet the organization’s overall business concept. In the healthcare sector, this is the interaction between patients and practitioners. Primary processes thus reflect the organization’s core business, in other words, its main source of living. Support processes are not directly involved in fulfilling the organization’s
business idea, but provide the core processes with the necessary supporting resources, such as employees, equipment, facilities, and materials. Support processes are, however, just as important to the success of the organization as core processes (Rentzhog, 1998; Rummler & Brache, 1996). Another important process is the management process which, according to Rummler and Brache (1996), includes actions that managers should take to support the organizational processes.

During the last decade, the healthcare sector has tried to move from functional to process-oriented organizational forms. Yet, healthcare organizations are still characterized by an increasing number of medical disciplines and specialized units (Lenz & Reichert, 2007). Traditionally, hospitals have a functional organizational structure. The functional organization is based on grouping individuals into organizational units, according to the function they perform, such as orthopedics, surgery, physical therapy, etc. In a functional organization, people who share common expertise and responsibility are grouped into independent units. Each unit works to achieve its organizational goals, independently of other units. A disadvantage of the functional organization is in its relationship with the patient. A patient is usually treated by various healthcare practitioners from different levels of care. During this process, the patient moves from unit to unit, receiving care from different practitioners as they go (Ben-Tovim et al., 2008). Since communication and collaboration between the various organizational units is deficient, due to the different goals, interests and background of the members of these organizational units, the patient may have difficulty receiving the care he/she needs (Shhtub & Karni, 2010). To improve the quality of care, it is necessary to overcome the traditional functional organizational structure. This can be achieved by the implementation of a process-oriented organizational structure (Vos et al., 2011).

Process orientation in healthcare (as in other organizations) means designing healthcare as a flow, or a process that reduces unnecessary repetition and preserves or increases the quality in the remaining activities (Söderström, Ählfeldt & Eriksson, 2009). The approach is defined by Eriksson (2005) as a patient’s total care contact with caregivers in a process to be carried out according to process guidelines and which are coordinated into a chain of activities. Moving toward process orientation can according to Willaert et al. (2007) provide numerous benefits, including cost savings through a more efficient execution of work, improved customer focus, etc. McCormack and Johnson (2001) have in their research found that companies with strong signs of process orientation also performed better. The study shows that the development of process orientation in an organization will lead to positive outcomes, both from an internal perspective and a resultant perspective. Process orientation has been shown to reduce inter-functional conflict and increase interdepartmental connectedness and integration, both of which impact long and short-term performance (Willaert et al., 2007). Also Gonçalves, Hagenbeek and Vissers (2013) emphasizes that moving toward process orientation will improve internal coordination, communication, speed, quality, financial performance, and increase customer satisfaction. By focusing on activities that create value for customers and regarding the organization as linked chains of activities, process orientation delivers a promising solution for a variety of perceived organizational problems in the healthcare and other functionally structured organizations (Gonçalves, Hagenbeek & Vissers, 2013). In a process-oriented organization, practitioners from different functions, such as orthopedics, surgery, physiotherapy, are thus all aligned towards satisfying the patients’ needs of care. In contrast, in a function-based organizational setting, the functions are disconnected from each other and from the process of satisfying patients’ needs (Kumar et al., 2009; Kohlbacher, 2010; Reijers, 2006; Balasubramanian & Gupta, 2005).

The starting point of a process-based organizational structure in healthcare requires the identification of the core business process. The patient process is considered as one of the most important processes by many healthcare organizations (SITHS, 1999; Ählfeldt,
An important aspect of a process-oriented organizational structure is thus that it focuses on the patients’ journey (process) through healthcare, instead of functional units. According to Vos et al., (2011), in a process-oriented organization, all the different disciplines involved in the delivery of patient care have to work together as a group and strive to achieve common goals. Implementing a process-oriented view within the healthcare sector implies that the organization will pay attention to the patient process and focus on satisfying a patient’s care needs, through the integration and coordination of healthcare services across organizational boundaries based on integration agreements (Tello-Leal, Chiotti & Villarreal, 2012). Working in teams empowers staff, decentralizes decision-making and allows greater across organizational learning (Gonçalves, Hagenbeek & Vissers, 2013; Tello-Leal, Chiotti & Villarreal, 2012). From an organizational viewpoint, process orientation enables the organizations to put the patients at the center of care. A process-oriented approach with supporting information systems is thus an important foundation for achieving a system design that focuses on the patient process from the patient’s perspective and thereby sets the patients and their healthcare journey in the center of care (Åhlfeldt, Persson, Krasniqi & Wåhlander, 2013; Perjons et al., 2005). In addition, adopting a process-oriented view will lead to a more, patient-centered care process, cost reductions, and quality improvements (Vos, et al., 2011).

In spite of the benefits offered by the process-based view, there are also some challenges in applying the process perspective. Organizations pursuing the process approach appear to have achieved only partial or marginal success, and in some cases, failure. The problems have been traced to a number of sources. One is in the difficulty of identifying processes, and a second is in their way of managing and redesigning processes (Kirka & Manning, 2005). Organizational processes represent a difficult challenge in identification and analysis because they are often unknown quantities, have no names, are not represented in organizational charts, and examples are often disputed. Processes are also difficult to identify because their boundaries are poorly defined. Processes are selected portions of larger streams of activity. Process boundaries must according to Kirka and Manning (2005) be set or established in this larger context, before they can adequately be identified. As boundaries are arbitrary, managers are faced with the task of defining them, and often these definitions will be contested, resulting in discrepancies and internal conflicts.

The process perspective has also been criticized for its apparent de-manning of the organization. This has according to Kirka and Manning (2005) been traced to the need for new styles of management that include the ability to coach, collaborate, communicate, motivate, negotiate and work as a team player. Those maintaining traditional management styles of command, control, resource allocation and assigning responsibilities may find themselves rooted out of organizations as these styles have no place in a process organization. Adopting the process view is thus often a big change and demands full commitment from the management. Without this commitment process orientation initiatives often fail to deliver the expected results. The severity and the immense complexity of necessary transformational changes could be too big for some managers and organizations, leading them to the failure track. Shifting to the process perspective is time consuming because it requires significant changes in corporate culture, work design, management and philosophy. Traditional managers may balk when they have to give up power and authority. Employees have to be trained to work effectively in a team environment (Sarlak, 2011). Despite these challenges, the process-based view is the proposed way of coping with the dynamism and complexity of organizations (Mathisen & Krogstie, 2012).
2.3 PATIENT PROCESS

The patient process in this thesis is defined in accordance with the definition of Winge et al., (2007):

“To denote the sequence of treatments and other activities performed by health or social care personnel for the patient and in which the patient and his relatives participate”

The definition implies that the patient process is the process that follows the patient through an event of illness. During this process, different activities are performed by healthcare practitioners in order to promote health. Patients whose conditions necessitate complex care needs require care from a wide range of caregivers, such as primary and secondary care doctors and nurses. Each of these actors generates information that is needed by the others. To ensure high quality and safe care, this information must be accessible to healthcare practitioners in a uniform and transparent way, anywhere and anytime, as required by the patient process. For instance, healthcare providers need to exchange information, such as clinical notes, observations, laboratory tests, treatments, therapies, drugs administered, allergies, x-rays, etc. However, due to interoperability issues, patient information is fragmented in the proprietary heterogeneous systems of healthcare organizations. Consequently, vital information stored in these systems cannot be easily accessed, in order to present a clear and complete picture of the patient. One example of a patient process and the care providers involved in the context of this process is presented in figure 2.2.

Figure 2.2 thus represents an abstract view of a real patient process and illustrates the care providers involved in the context of this process. In this example, 42 different contacts between the healthcare providers and the patient were made. The number of contacts be-
tween the healthcare providers is not known. 20 of the 42 contacts, of which 14 were made by the patient, were due to the poor management of information. Moreover, the whole process was extended by two and a half months, due to the ineffective exchange of information (Åhlfeldt, 2008). Organizational processes are frequently modeled internally in the organization. However, no one, to the best of our knowledge, has modeled the patient process, although some projects, as “VITA Nova Hemma”, have indicated the need for this kind of work (Perjons et al., 2005).

2.4 BASIC CONCEPTS OF KNOWLEDGE MANAGEMENT

Researchers in the information system community address the question of defining knowledge by distinguishing it from data and information. The assumption, according to Fahey and Prusak (1998), seems to be that if knowledge is not distinguished from data and information, then there is nothing new about knowledge management. A commonly held view is that data are raw numbers and facts where the context or organization is not established, while information is data presented in context, with some purpose and a discernible organization that will have relevance to a situation, problem or some other condition (Wiig, 1994, p. 81; Wickramasinghe, Gupta & Sharma, 2005). Maglitta (1996) in Alavi and Leidner (2001) defines data as raw numbers and facts, information is data that have been processed and knowledge is information made “actionable”. Alavi and Leidner (2001) argue that raw data do not exist. They suggest that even the most elementary piece of data has been influenced by the thought that led to its identification and collection (Alavi & Leidner, 2001, p. 109). Davenport and Prusak (1998) describe information as a message, usually in the form of a document or an audible communication. As with any message, information has a sender and a receiver and aims to change the way the receiver perceives something. Knowledge is seen as broader, deeper and richer than data and information. Davenport and Prusak (1998) suggest that knowledge originates and is applied in the minds of people. In organizations, knowledge becomes embedded in documents, repositories, routines, norms and processes. Alter (2006), in accordance with Davenport and Prusak (1998), views knowledge as an evolving mix of framed experience, values, contextual information, and expert insight that provide a framework for evaluating and incorporating new experiences and information. Knowledge is thus necessary for using information effectively, regardless of how brilliantly the information is gathered and combined. In fact, people use knowledge about how to format, filter and summarize data as part of the process of converting data into information (Alter, 2006). Nonaka & Takeuchi (1995) expand this view by claiming that knowledge is context-specific. In order for knowledge to have a meaning for the users, they must understand and have experience of the context, or surrounding conditions and influences, in which the knowledge is generated and used. In accordance to Alavi and Leidner (2001), we posit that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text and words. An important implication of this definition of knowledge is that in order for individuals to arrive at the same understanding of data and information, they must share a certain knowledge base. Another significant implication of this view of knowledge is that since knowledge exists in the human mind, it cannot be stored in an information system. However, through the use of information technology, we can process and store information that supports knowledge transformation (Swan et al., 1999).

Knowledge is also defined as either (1) state of mind, (2) an objective, (3) a process, (4) a condition or having access to information, or (5) a capability (Alavi & Leidner, 2001). Knowledge viewed from the perspective of “state of mind” suggests that knowledge is the
fact of knowing and knowing is a condition of understanding gained through experiences. From this perspective, it is not possible to computerize knowledge (Schubert, Lincke & Schmid, 1998). According to knowledge as “state of mind”, the role of information technology in KM is to enable users to search and retrieve information (Alavi & Leidner, 2001). By making information available when it is needed, physicians can expand their knowledge and apply this to clinical situations. Knowledge as an objective posits that knowledge can be stored and manipulated independent of people. The process perspective focuses on knowledge flow and the process of creating and sharing knowledge. The fourth view can be seen as an extension of the view of knowledge as an object. It posits that organizational knowledge must be developed and organized to facilitate access (Alavi & Leidner, 2001). Finally, “knowledge can be viewed as capability with the potential for influencing future action” (Alavi & Leidner, 2001, p. 110). These different views of knowledge lead to a different strategy for knowledge management (KM) and different perceptions of how IT can support KM. The perspective of knowledge relied on in this thesis is that of Davenport and Prusak (1998), Alavi and Leidner (2001) and Alter (2006) and is related to knowledge as “state of mind” and as a “process”.

Additionally, two dimensions of knowledge in organizations have been identified; tacit and explicit. Nonaka (1994) argues that knowledge that can be expressed in words and numbers only represents the tip of an iceberg of the entire body of possible knowledge. Explicit or documented knowledge refers to knowledge that is transmittable in formal, systematic language. On the other hand, tacit knowledge has, according to Nonaka (1994), a personal quality which makes it hard to formalize and communicate. Nonaka (1994) further argues that tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context. The presence of both explicit and tacit knowledge is evident in the healthcare sector. Explicit knowledge is available, e.g., in EHRs, research reports, memos, e-mails, books and manuals. Explicit knowledge can in turn arise from both internal and external sources. Internal is all knowledge that is relevant to the practice of medicine, e.g., medical journals, and also the skills and expertise of practitioners (e.g., nurses, physicians, managers). External is indirect knowledge: legal, governmental and other documents that do not directly affect patient treatment, but govern general medical practices (Wickramasinghe, Gupta & Sharma, 2005). However, the knowledge embodied in, e.g., journals does not necessarily and automatically convert into useful and usable knowledge, unless it is processed in the minds of individuals and used. In other words, knowledge can only reside in the minds of people (Acharyulu, 2011). Tacit knowledge, as mentioned earlier, is a type of knowledge that exists in the minds of practitioners and is a result of people interacting with each other and with the environment around them. This type of knowledge is also called know-how knowledge and can be in the form of skills and competencies acquired through training and interaction with the environment. Alavi and Leidner (2001) see a danger in the classification of knowledge according to the dimensions of tacit and explicit, as there seems to be an assumption that tacit knowledge is more valuable than explicit knowledge. Based on the previously stated definitions of evidence based medicine, we argue that both tacit and explicit medical knowledge is crucial, when making decisions about the care of a patient.

2.5 DEFINITION OF KNOWLEDGE MANAGEMENT

Knowledge is considered to be the most valuable and critical asset of the organization. With the entry into the “global knowledge society” where knowledge provides competitive advantage, many consider KM a useful tool for business transformation and a key factor in gaining and sustaining a competitive advantage (Wiig, 1994; Davenport and Prusak, 1998; Jennex, 2007). A general goal of KM, according to Heisig (2009), is to enhance the systematic handling of existing and potential knowledge within the organization.
Although the term knowledge management is widely used, there is no established definition. Instead, there are varying opinions on what it is and how it should be used, if used at all (Jennex, 2007; Jennex & Olfman, 2002). A contributing factor to this may be that KM is drawn from a wide range of established disciplines, such as organizational learning, social construction and social interaction (Senge, 1994; Nonaka & Takeuchi, 1995) resulting in a multiplicity of terms that are often used interchangeably. Lack of consensus and precision in terminology has resulted in conflicting definitions of KM (Beesley & Cooper, 2008; Hicks, Dattero & Galup, 2006). Hicks, Dattero and Galup (2006) state:

“There is a consensus that data are discrete facts, but after that, consensus is lacking. The lack of consistent definitions of data, information, and knowledge make rigorous discussions of KM difficult” (Hicks, Dattero and Galup, 2006, p. 19).

Jennex (2005) describes KM as the practice of selectively applying knowledge from previous experiences of decision-making to current and future decision-making activities, for the express purpose of improving the organization’s effectiveness. Another key definition includes Malhotra (1998), who considers that KM is the process established to capture and use knowledge in an organization, for the purpose of improving organizational performance. Alavi and Leidner (2001) have also a process view of KM. They argue that KM involves distinct but interdependent processes of knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application. Both Jennex (2005) and Malhotra (1998) argue that KM concerns managing knowledge in such a way that benefits the organization. Additionally, Heisig (2009) expands the definition by also including the management of tacit and explicit knowledge. He argues that knowledge is managed through specified processes for sharing, creating, using, storing and identifying both the tacit and explicit knowledge of employees, for the purpose of enhancing organizational performance and creating value (Heisig, 2009). Persson and Stirna (2007) have a similar definition. They argue that KM consists of a number of processes that cover the whole life cycle of knowledge in an organization (see figure 2.3). The cycle is adopted from O’Dell et al., (1998) and is similar to the spiral of organizational knowledge creation presented by Nonaka and Takeuchi (1995). The model consists of four socially enacted “knowledge processes”: capture and create, package and store, share and apply, transform and innovate. Carrying out each of the four processes entails, according to Alavi and Leidner (2001), some degree of social knowledge and interaction, even if the process is focused on explicit knowledge. This is because individuals’ tacit knowledge is captured and represented in explicit form. Furthermore, if information technology is utilized to store and share knowledge, the interpretation of its output will be affected by social processes. A key strength of the KM process model proposed by Persson and Stirna (2007) is the emphasis on knowledge innovation (transform and innovate). This activity highlights the importance of transforming shared information into knowledge which is in the human mind. People must thus learn from shared information and learn to apply it in practice (Desouza, 2005).

Furthermore, Kezar (2005) argues that KM refers to the process during which organizations assess the data and information that exist within them, and the processes that make the data and information meaningful and usable in the form of knowledge. Additionally, Hari, Egbu and Kumar (2005), referring to Newman (1996), conclude that KM “directs and enhances organizational decisions as to how, where, and when to create and account for new knowledge”. Newman’s (1996) definition clearly states that KM is essential for managing knowledge in such a way that benefits employees’ knowledge creation and usage, and the organization, by preventing knowledge loss. Capturing knowledge, thus prevents the loss of critical knowledge and increases organizational knowledge (Hari, Egbu & Kumar,
A similar definition is given by Jones and Leonard (2009) who argue that KM is the "process of acquiring knowledge from the organization or another source and turning it into explicit information that the employees can use to transform into their own knowledge allowing them to create and increase organizational knowledge" (Jones & Leonard, 2009, p. 28). Similar to Newman (1996), Jones and Leonard (2009) emphasize that KM can help organizations capture the tacit knowledge of their employees and change it into organizational knowledge which can be used, even if the employee leaves the company. In this way, the organization prevents knowledge loss.

Finally, Swan, Scarbrough and Preston (1999) conclude that KM is the "process or practice of creating, acquiring, sharing and using knowledge, wherever it resides, to enhance learning and performance in organizations" (Swan, Scarbrough & Preston, 1999, p. 669). KM, according to this definition, refers to the process in which organizations acquire information, store and share it, so that individuals in the organization can transform it into knowledge, for the purpose of learning (Aggestam, 2008; Loermans, 2002). The inclusion of "wherever it resides" refers not only to explicit knowledge, but also tacit knowledge that resides in people’s minds (Loermans, 2002). When users utilize, e.g., stored information that is relevant to the task at hand, and if the knowledge per se is new to the individual, information will be used and applied. When knowledge is used, a learning process takes place at an individual level (Aggestam, 2008). In order to transform individual knowledge into value which can benefit the organization, the individual knowledge must be transformed back into information. The captured knowledge must be stored as information and will again provide a foundation for the creation of new individual knowledge (Jensen, 2005).

Some researchers, such as Davenport and Prusak (1998), have claimed that tacit knowledge cannot be managed. They even claim that if tacit knowledge is viewed as a part of KM, then the term becomes a misnomer (Loermans, 2002). However, Nonaka and Takeuchi (1995) argue that explicit knowledge is only the tip of the iceberg. Given that knowledge, both explicit and tacit, is critical for an organization, this thesis concludes that KM is to include all knowledge. Subsequently, Loermans (2002) concludes that KM should include both explicit and tacit knowledge; otherwise, it would be difficult to distinguish it from information management.

In conclusion, according to the definitions provided by the aforementioned researchers, KM concerns the process that aims to capture and use knowledge in an organization. When capturing accurate knowledge that is effectively used by employees, the organization can improve its performance. The definition used in this thesis is influenced by the proposed definition given by Persson and Stirna (2007), Abidi (2008), Alavi and Leidner (2001) and Swan et al. (1999):

**The goal of KM is to promote and provide relevant and timely knowledge (both explicit and tacit) to healthcare practitioners where and when they need it to help them make high quality and well-informed patient care decisions. It includes the process of capturing, storing, sharing and using knowledge, wherever it resides, to improve the quality of patient care. In practice, KM is pursuing this goal through the use knowledge-mediated solutions and their integration in healthcare practitioners work practice.**

The above definition concludes that the goal of KM, is to guide/support healthcare practitioners in applying relevant knowledge, where and when they need it, in order to help them practice evidence based medicine. In practice, KM is pursuing this goal through the advancement of innovative knowledge-mediated solutions and their integration in organizational workflows (Abidi, 2008, p. 3). Only when this knowledge is made available to others and used by the members will it improve the quality and safety of care. Abidi (2008) em-
phasizes that the adoption of KM in healthcare advocates a healthcare delivery system that values medical knowledge as a vital resource to improve health outcomes. Abidi (2008) further stresses that each healthcare practitioner has unique and specific knowledge needs, depending on the clinical circumstance. Therefore, healthcare practitioners are not just asking for mechanisms to easily access knowledge, but rather the incorporation of *current* and *relevant* knowledge into daily work activities to support healthcare decisions (Abidi, 2008).

![Figure 2.3: The knowledge cycle in organizations (Persson & Stirna, 2007).](image)

To summarize KM, knowledge is a critical resource in any organization. Its members’ ability to retrieve and apply knowledge to organizational activities is crucial in the provision of healthcare. KM deals with the process that makes knowledge actionable to members of the organization. It involves the process of creating, capturing, packaging, storing, sharing and using knowledge. Successful as well as effective knowledge sharing and application turns into innovation - improvement of existing knowledge and creation of new knowledge. This essentially closes the knowledge cycle (Persson & Stirna, 2007).

It is important to note that none of the above definitions of KM are purely technical in nature. KM involves information technology as an enabler, but the actual KM is carried out by the individuals in the organization (Persson, Stirna & Aggestam, 2008). KM consists thus of a number of interrelated activities that may be supported using information technology. For example, one way to provide appropriate knowledge to those that need it when it is needed is to implement IT-based knowledge repositories that also prevent knowledge from being lost when a specific employee leaves the organization (Aggestam, 2008). IT-based knowledge repositories, which are sometimes called Electronic Knowledge Repositories (EKR) or Digital Learning Repositories, are important solutions to the problems identified in this thesis. IT-based knowledge repositories help organizations connect people with information and expertise for instance via online searchable libraries, discussion forums and other elements. Thus, they provide a central location to collect, contribute and share both explicit and tacit knowledge.
Moreover, for KM to be effective as a transformation tool, it must include an organizational culture that promotes learning and knowledge sharing. A manager that is personally committed to learning and regards the sharing and use of best practice as critical for providing good quality care, is also crucial. Information technology and KM have a symbolic relationship, but it is important that technology does not become “the be all and end all” of KM. Information technology can connect people, but it does not make KM happen. Developing and implementing, for example, an IT-based knowledge repository does not, in itself, guarantee the usage and sharing of best practice and know-how. In fact, too much technology, or the wrong type of technology, can hamper KM efforts (O’Dell, Grayson & Essaides, 1998; Aggestam, 2008). However, if information technology in KM practice is used correctly, it will open up a new world to KM. For example, it can enhance knowledge creation, capture, storage, sharing and use of knowledge (Alavi & Leidner, 2001).

2.6 IS HEALTHCARE IN NEED OF KNOWLEDGE MANAGEMENT

Healthcare organizations are facing many challenges, due to changes taking place in global healthcare systems (Sharma, Wickramasinghe & Gupta, 2005). Sharma, Wickramasinghe and Gupta (2005) argue that financial constraints, the growing complexities of research in medicine, increased requirements from patients and advances in information technology have strengthened the importance of incorporating the KM paradigm shift. Further, the healthcare sector is information intensive, since it uses multiple knowledge areas, such as those of medicine, and policies that assist healthcare practitioners in making decisions. These multiple knowledge areas and the large number of interdependent disciplines make the healthcare organization a knowledge intensive organization (Wahle & Groothuis, 2005). Additionally, since the healthcare organization is traditionally divided into different levels, primary, specialist, and municipality care, it has resulted in the development of small but very specialized areas of practice. As a result, the specialized practitioners have unique tacit and explicit knowledge that has to be captured, disseminated and utilized by other practitioners (Wahle & Groothuis, 2005). The specialization has also resulted in practitioners that “know more and more about less and less” (Desouza, 2005, p. 14). Desouza (2005) argues that physicians use about two million pieces of information to manage their patients. It is estimated that medical knowledge increases fourfold during a practitioner’s lifetime. Inevitably, this means that practitioners cannot practice EBM without updating their knowledge. Furthermore, practitioners are also facing greater demands from patients that are increasingly interested in participating in decision-making regarding treatment choices and care possibilities (Desouza, 2005). El Morr and Subercaze (2010) further emphasize that any knowledge created by healthcare practitioners, irrespective of healthcare level, is of utmost importance to all others, in order to provide good quality care. Efficient interaction and exchange of knowledge among these actors is therefore a key issue for creating the best conditions for good quality care (Nicolini et al., 2008). Effective collaboration in turn requires that relevant medical knowledge is made available, as needed, at any time of the day and without technical difficulty (Wickramasinghe, Gupta & Sharma, 2005; Abidi, 2007). Having access to the latest medical knowledge can, according to Grüttner and Eder (2002), mean the difference between life and death and between an accurate or erroneous diagnosis. Managing knowledge in healthcare organizations is hence crucial for the optimal achievement of good quality care (Desouza, 2005)

Managing medical knowledge in healthcare organizations thus holds great promise for improving healthcare delivery and, more critically, for dealing with information overload (Ali, Tretiakov & Whiddett, 2009; Acharyulu, 2011). Wahle and Groothuis (2005, p. 30) have
identified some arguments regarding why healthcare organizations need KM. The arguments are:

- Healthcare organizations are knowledge intensive.
- There is a need and demand for optimizing the support of primary processes.
- Increased requirements from the patient for higher quality care and provision of information related to treatment choices and care possibilities.
- The demand for efficiency and effectiveness.

### 2.7 KNOWLEDGE MANAGEMENT AND ORGANIZATIONAL PROCESSES

KM is considered to be an important function for creating organizational value. However, for organizations to gain maximum benefits from KM, they must link KM activities to organizational processes, such as the patient process (see figure 2.4) (Barnes, 2011). Edwards & Kidd (2003, p. 133) assert that the best route for organizations to follow is to consider KM in terms of organizational processes. This means looking at knowledge needs in terms of their underlying business processes. El Sawy and Josefek Jr (2004) argue that the application and generation of new domain knowledge take place in the context of the process. Therefore, the key activities of the process are the central objects for analysis and design, and KM has to demonstrate its benefits for the core processes (Heisig, 2009). Additionally, Mertins, Heisig and Vorbeck (2003) and Deng and Yu (2006) argue that knowledge from a process-oriented approach can be viewed as a crucial resource to fulfill process tasks. It can also be understood as a product generated by this task or process (see figure 2.4). The authors further emphasize that a process-oriented knowledge management approach requires an integrative perspective of the elements of information and knowledge, as lack of one of the elements can hamper the performance goals. Implementing the KM infrastructure around the organizational process can thus create great value for process execution, process recipients and the organization (El Sawy & Josefek Jr, 2004).

![Figure 2.4: Knowledge is a crucial resource to fulfill the activities within the process.](image-url)

Deng and Tian (2008) and Deng and Yu (2006) argue that KM activities which are not combined with daily work tasks and integrated into organizational processes usually results in situations where employees involved in the execution of the process feel that “they are busy with the execution of more important tasks related to the process and that they do not have time to spend on knowledge management activities such as searching for relevant knowledge” (Deng & Tian, 2008; Deng & Yu, 2006). Therefore, integrating KM activities into daily work tasks and responsibilities is a challenge to be solved. In recent years, indus-
tries have increased their attention to the potential benefits of linking KM to organizational processes. However, to date, linking KM to processes has had less focus in healthcare organizations. This is somewhat surprising, as the patient process is characterized as knowledge-intensive, consisting of many and critical decision activities that require personal judgment based on patient information and scientific evidence.

Consider the following hypothetical example in which the KM process and organizational processes are interlinked. The setting is a healthcare organization where the core organizational process is the patient process. A specialist care physician receives a referral from a primary care unit regarding a patient with hip pain. As the referral is processed and the process for the patient encounter is planned and conducted, a considerable amount of information is collected, such as information from physical examinations, the patient's medical record, and from current scientific medical knowledge. A great deal of information is also exchanged between the patient and the physician and between the specialist care physician and the primary care unit. When the physician plans the patient encounter and conducts the meeting, he/she must select the most appropriate examination and investigation for the patient, based on the basis of evidence in conjunction with clinical expertise, the patient's medical history, current clinical status, as well as preferences and values (Clancy & Cronin, 2005; Lenz & Reichert, 2007). The patient encounter also requires the physician to carry out some sort of decision-making, which involves an active interplay between various medical knowledge modalities, spanning from explicit to tacit knowledge. More specifically, it may involve the consideration of medical knowledge from outside and inside the organization, such as (a) national and/or regional medical guidelines, (b) medical literature, (c) physician's tacit knowledge in terms of judgment and intuition, (d) discussions and consultation with other practitioners. Enabling a healthcare practitioner to work according to the latest scientific medical knowledge will require an analysis of the type of knowledge needed in the different parts of the patient process. This knowledge, which may be in the form of medical guidelines, can then be integrated with an information system. However, beyond medical guidelines, a doctor may also need a different type of medical knowledge and an information system must therefore support the doctor in identifying the required knowledge in an easy way. To make decisions based on EBM, practitioners must be able to access and integrate multiple knowledge types derived from various sources. Integration of these knowledge types (both tacit and explicit knowledge) is especially essential, as healthcare practitioners often have to deal with clinical situations which lack strong evidence. For instance, the absence of explicit knowledge in a clinical case relating to the side effects of a particular medicine reported by the patient may require practitioners to refer to tacit knowledge, such as the clinical expertise of their peers (Abidi, 2005).

Additionally, every time the process is executed, new knowledge can be generated, e.g., if a medical guideline recommends a new medication, patients' experiences of the medication become important knowledge that must be captured and shared. Capturing, storing, sharing and applying this knowledge can add value to the organization, but most importantly, it can improve quality of care. Knowledge that has been identified and captured by a physician can thus be used to improve the patient process. However, for this to work, the KM process must be smoothly integrated within the daily work activities of the patient process, see figure 2.5 (Persson, Stirna & Aggestam, 2008). For example, if an organization wants to develop an IT-based knowledge repository that is integrated within a process support system, work must begin with 1) identifying what knowledge can be relevant for the execution of the different activities in the patient process, 2) identifying where the knowledge could be found, also called “capture points”, which are situations or events where knowledge is usually created, e.g., during a patient encounter, 3) identifying responsible people for the capturing process. If, for example, a doctor has identified knowledge that he/she perceives may be of interest to other colleagues, the doctor would then report to
those responsible. In this process, one must also identify potential reviewers of the particular type of knowledge produced, 4) defining rules governing the kind of knowledge that should be stored in the repository and in the process support system (Persson, Stirna & Aggestam, 2008).

The integration of the KM process alone is, however, not sufficient for successful knowledge management. The success of KM activities is also influenced by the enablers: leadership, measurement, information technology and culture (see figure 2.5). For example, the sharing and application of knowledge cannot be done mechanistically, by integrating medical guidelines into an information system, or by developing an IT-based repository that supports sharing of knowledge, thus expecting the organization to suddenly start to use and share knowledge. Particular attention should be paid to building a knowledge sharing culture. A culture that encourages sharing and group learning helps KM initiatives. Technology can only play a supporting role in knowledge sharing and application – its role is to make knowledge sharing and application easier and more effective. To reinforce the knowledge application and sharing, leadership is critical. Managers must participate in sharing and show healthcare practitioners that they are personally committed to learning, as sharing and usage of best practice are the most important aspects that individuals within an organization can do (O’Dell, Grayson & Essaides, 1998; Persson, Stirna & Aggestam, 2008). They must motivate employees to share and especially show employees how to capture, share and use knowledge throughout the patient process, by giving people self-service tools. The Chinese proverb fits well here; “Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime”. Thus, in order to encourage sharing, managers should not just hand out, e.g., web links where knowledge can be found - give the fish. Instead, they must teach by giving employees the right tools with which to capture and share knowledge – thus teaching them how to fish. Moreover, it is equally important to encourage practitioners to teach each other – learning how to fish from each other.

Figure 2.5: The integration of KM into organizational process and its enablers
2.8 THE RELATIONSHIP BETWEEN EBM, PROCESS ORIENTATION AND KM

The definitions of the concepts and theories in the previous sections demonstrate a clear relationship between evidence based medicine, business-process orientation, and knowledge management (see figure 2.6). EBM aims to deliver high-quality care to an individual patient, by eliminating decision-making based on more traditional methods in favor of using scientific proof together with patient information, values and preferences, and clinical skills. By integrating these elements into the decision-making, it will provide a stronger foundation for clinical work to achieve consistency, efficiency, effectiveness, quality, and safety in medical care (Timmermans & Mauck, 2005). With an increased awareness of the need for evidence based decision-making, knowledge management needs to be employed to ensure that knowledge is easily accessible, tailored, and shared among healthcare practitioners. KM is also central to EBM, as it involves organizations and individuals that create, capture and share both explicit and tacit knowledge (Quinn et al., 2014).

To ensure that relevant medical knowledge is made available to practitioners’, healthcare organizations must adopt KM. Therefore, theory of KM has been described and discussed in this chapter. However, successful knowledge management efforts require that KM activities are embedded into organizational processes. These can be any organizational process, for example, the patient process. Once the process has been selected, information regarding the kind of knowledge that will flow through the process and what knowledge is needed during the different activities within the process must be identified and documented (Barnes, 2011). As EBM comprises explicit and tacit knowledge, theory of KM can be used to show how it can be linked in the execution of organizational processes, in order to ensure that only relevant medical knowledge is made available in the context of this process. Thus, by grounding KM activities around the process, it can help the organization understand the knowledge needs of health practitioners during the different parts of the process. Hence, it will be possible to ensure that only relevant knowledge for the specific process is made available to those who need it, when they need it (El Sawy & Josefek Jr, 2004).

Moreover, EBM comprises patient information, preferences and values. In order to improve the quality and safety of care, this information needs to be available when decisions about the care of individual patients must be made. Therefore, the concept of process orientation has been adopted in this thesis. Process orientation places emphasis on organizational processes based on the patient perspective, instead of placing emphasis on functional and hierarchical structures (Kohlbacher, 2010). A process-oriented approach with a supporting information system is crucial, as it can streamline the flow of both patient information and medical knowledge, and thereby ensure that practitioners always have access to the right information when decisions must be made. Moreover, in order to contribute to improvements in healthcare, one must view patient information and medical knowledge as interconnected, continually impacting on each other. Therefore, when future healthcare information systems are developed, they must consider the synergy between EBM, process orientation and KM.
2.9 RELATED RESEARCH

In recent years, researchers have tried to resolve the gap between evidence and practice, by introducing different solutions for how information systems can be used to support evidence-based medicine. For example, Winge et al., (2014) propose a solution in the form of a Coordination Hub, an integrated software service that offers a number of information services, which can facilitate the communication between different healthcare providers in process conglomerations, thereby supporting patient-centered collaboration. Raghupathi and Kesh (2007) have, in their research, explored the potential of service-oriented architecture (SOA) in the development of interoperable EHRs, by developing a prototype SOA model. Russ et al., (2010) have identified a set of characteristics for workflow systems that support patient-care processes. The research from, e.g., Winge et al., (2014) and Russ et al., (2010) focuses on the communication needs of care providers and how the patient process can be supported, by making individual patient information available at all points of care, which of course is of interest for this work. However, none of these have taken a holistic perspective that also includes the patient and their communication with healthcare providers.

Moreover, there is much research on different methods and tools for 1) translating clinical guidelines into computer-based clinical guidelines and 2) improving the design of computer-based clinical guidelines (see, e.g., Shalom et al., 2008; Shiffman et al., 2004). Other researchers have focused on studying how clinical guidelines can be integrated into EHRs and organizational workflows (see, e.g. Peleg, Keren & Denekamp, 2008; Shiffman et al., 2004). For example, Peleg, Keren and Denekamp (2008), in their research, have studied how encodings of guidelines in a computer-interpretable format and integration of them with EHRs can enable the delivery of medical knowledge, in the form of patient-specific recommendations, when and where needed. El-Gayar and Timsina (2014) have, in their research, presented a research agenda for leveraging business intelligence and big data analytics in evidence based medicine, and illustrate how analytics can be used to support EBM. Furthermore, in their research, Lenz et al., (2007) have demonstrated how pathway compliance can be improved, by developing a successful IT-application that brings pathway recommendations to the point of care. The application is closely integrated into the elec-
tronic patient record system and is based on workflow-enabled electronic forms in which coded data from a central database are reused to place reminders and alerts. As the main purpose of computer-based clinical guidelines is to decrease errors and increase quality and safety, validation and verification techniques are other topics of interest to many researches (Peleg, 2013). Although computer-based clinical guidelines include medical knowledge, the management of knowledge from a KM perspective is seldom mentioned in these research examples. Moreover, Fennessy and Burstein (2007), argue that computer-based medical guidelines provide important summaries of good quality evidence, but they are usually limited in scope and topic coverage. High costs and the amount of time involved in developing them are seen as the main reasons. Therefore, and as a complement to computer-based medical guidelines, IT-based knowledge repository solutions have been implemented within healthcare organizations, but the results have often been unimpressive.

In Sweden, several national projects have been initiated, with the aim of developing IT-based knowledge repositories. The solutions are built on web-based services that help practitioners access and use explicit medical knowledge. Some well-known project initiatives are “Kunskapsguiden” and “Vårdaktörsportalen”. These IT-based knowledge repositories aim to give healthcare practitioners easy access to explicit medical knowledge, such as medical guidelines, without supporting the second element of evidence based medicine, namely sharing of individual clinical expertise. Moreover, the medical knowledge within these knowledge repositories is made available in “document form”, containing a multitude of pages. Even though these knowledge repositories contain crucial knowledge, none of them are integrated with existing information systems, such as an EHR. They are thus “stand-alone” systems that have been developed and are still being developed separately from existing information systems. Finding relevant knowledge that is related to the clinical situation, when it is needed, is therefore difficult.

An important project that forms the basis for this thesis is VITA Nova (acronym for Swedish “Vårdens IT-Arkitektur i Ny belysning”). The aim was to develop a methodology for, and to investigate the potential of, process manager technology in healthcare. In the project, a prototype system based on a process manager was built, integrating the work of the various healthcare units along a limited patient process (the leg ulcer process). The focus was on home healthcare providers using mobile devices that communicated with IT systems via a process manager (Perjons et al., 2005). The process manager has been used in the prototype developed within case study one, “Future Healthcare Information Systems project”, which is part of this thesis.

Based on the analysis of prior research and the scope of the problem that has been presented in this thesis, we conclude that the various elements of evidence based medicine are treated as distinct. Consequently, the information technology solutions that are presented in current research deal with supporting one or some other elements of EBM. A holistic perspective is thus missing. Information technology can contribute significantly to quality and safety improvements in healthcare, only when 1) patient information and medical knowledge are regarded as interconnected, such that they continually impact on each other, and 2) when the patient is seen as a distinct and active collaborator. Therefore, an efficient synergy must be developed between future information systems and EBM. An additional limitation in existing research relates to the presented solutions for how medical knowledge can be made available to healthcare practitioners. It seems that existing research is either studying how guidelines can be integrated into EHRs or how IT-based knowledge repository solutions can bridge the gap between evidence and practice. Considering that medical guidelines provide summaries of evidence, future research should also examine how an IT-based knowledge repository can be used as a complement to computer-based medical guidelines.
CHAPTER 3
RESEARCH METHOD

This chapter first describes the research approach applied to the research presented in this thesis and then presents the research process. The chapter concludes with a discussion regarding ethical principles that have been considered while conducting the research.

3.1 APPROACHES TO RESEARCH

Research methods can be classified in various ways. Myers (1997) explains that one of the most common distinctions between research methods is that between qualitative and quantitative research. Quantitative research methods originate from the natural sciences and aim to study natural phenomena. Examples of quantitative methods include surveys, laboratory experiments, as well as formal and numerical methods. Qualitative research methods, on the other hand, aim to study social and cultural phenomena based on a complex, holistic picture, formed with words, and reported in a natural setting (Myers, 1997; Jabar, 2009). Qualitative research methods are designed to help researchers understand people, as well as the social and cultural circumstances in which they live, by enabling them to verbalize thoughts about the context under study. Qualitative researchers are interested in the beliefs, feelings and interpretation of people (Williamson, et al., 2002). Hence, they tend to use qualitative research methods, such as action research, case study research and ethnography. Qualitative techniques for data collection include observations, interviews, questionnaires and text analysis (Myers, 1997). In qualitative research, the research participants are viewed as “helping to construct the reality with the researchers” (Robson, 2011, p. 24). Bridget Byrne (2004) in Silverman (2008) suggests that qualitative interviewing is “particularly useful as a research method for accessing individual’s attitude and values – things that cannot necessarily be observed or accommodated in a formal questionnaire”. The author further argues that “open-ended and flexible questions are likely to get a more considered response than closed questions and therefore provide better access to the interviewees”, interpretation of events, understandings, experiences and options... [qualitative interviewing] when done well is able to achieve a level of depth and complexity that is not available to other, particularity survey-based, approaches” (Silverman, 2008, p. 114). Kaplan and Maxwell (1994) also argue that the goal of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified.

Qualitative research methodology is viewed as significant in information system research, due to the value of capturing and explaining what is going on in real organizations (Jabar, 2009). Additionally, as information systems research shifts from technological to managerial and organizational issues, qualitative research methods become increasingly useful (Myers,
Our field of study involves a complex social context in which the care of the patient evolves from an isolated process towards a continuous one that incorporates multiple independent units and different healthcare practitioners, each with their own requirements and expectations of healthcare information systems. The social context makes it difficult to use controlled experiments and/or survey methods. There may be some aspects of the area that could be investigated by survey methods, but considering the research questions of the thesis, we have strong doubts about the relevance and effectiveness of such an approach. In conclusion, we argue that answering the research questions requires a research approach that focuses on understanding people and the social and cultural contexts in which they communicate and act.

Taking the aim of this thesis and the discussion about the research methods into consideration, we conclude that the case study approach in combination with data collection techniques, such as interviews and observations, were the most appropriate methods to use, in order to gain empirical data. A detailed description of the research process and the data collection techniques that were used for each case study are described in the next section.

### 3.2 Research Process

The research is based on two case studies (see figure 3.1). In 2009, a research project, Future Healthcare Information Systems (FHIS), was initiated. This case study started before I formally entered into my doctoral education. When I entered the project, interviews and observations with healthcare practitioners and patients had already been carried out as part of the first research activity “A current state analysis” (see section 3.3.1). I entered the project in the later phase of this research activity, where the plan was to carry out “As-Is” process models. Therefore, my work as a participant researcher in the FHIS project started with analyzing the collected data from the interviews and observations and carrying out process modeling. I have also had a central role in the development and evaluation of the process support system that is a central part of this work. The results of this case study have directly contributed to research questions 1, 2, 3 and 4. Shortly after the FHIS project, I entered the “Knowledge repository project” (KRP) which was a collaborative venture between Vårdsamverkan Skaraborg and the University of Skövde, Sweden (see figure 3.1). I had a leading role in this case study for which I planned and executed the research. I also had the sole responsibility of analyzing the empirical data. Interviews were the main data collection technique used to collect the empirical data. The results of this case study contributed to research questions 2 and 3. Moreover, within each case study, a literature review was carried out in two distinct phases – an initial phase that aimed to gain knowledge about the studied object and an adaptive phase where the literature was used to understand the empirical results in relation to existing research.
3.2.1 LITERATURE REVIEW

According to Webster and Watson (2002), a literature review of prior research is an essential feature of any academic project, since it creates a firm foundation for advancing knowledge. Moreover, “it facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed” (Webster & Watson, 2002, p. xiii). A literature review comprising two phases was carried out within each case study. In the initial phase, the literature review involved identifying, locating, and analyzing documents containing information related to the research problem. This phase helped to gain knowledge about the studied object, which included (Robson, 2011):

- Gaining knowledge about what is already known in the field of interest.
- Exposing gaps in knowledge and identifying principal areas of dispute and uncertainty.
- Identifying variations of definitions used by researchers.
- Identifying general patterns to findings from multiple examples of research in the field of EBM, business process orientation and KM.
In the adaptive phase, the aim of the literature review was to understand the empirical results in relation to existing research.

In order to identify relevant papers, the literature review started with the identification of keywords. These were found by analyzing the concepts that are used in the research problem and research questions. Some of the keywords used include: “information system and healthcare processes”, “knowledge management and knowledge management processes”, “evidence based medicine and knowledge management”, “patient engagement”, “evidence based medicine and information systems”. When these keywords had been identified, the literature review started with a general search of scientific papers through the use of various databases, such as Worldcat Local, ScienceDirect, Google Scholar and MEDLINE (PubMed). Papers were also found by searching in leading journals, such as Information Systems Research, MIS Quarterly, Health Informatics Journal, and Journal of Knowledge Management. As the search continued, alternative useful words that occurred during the searches were added to a keyword list.

Papers were selected through reading the title and abstract. The reading of papers was iterative, which means they were read several times, in order to ensure a correct understanding of the content. Relevant phrases and concepts were underlined and summarized. While reading the papers, I also paid attention to the reference list of each paper. The purpose was to use Bates’ technique of “linking” (2002), which aims to find new references from the reference lists of others. The paper by Lenz & Reichert (2007) made an early impression, because this paper has contributed to the identification of other relevant literature, such as Bemmel and Musen (1997) who emphasize the importance of having access to patient information and medical knowledge in medical decision-making.

3.2.2 CASE STUDY RESEARCH

Case study research is the most common qualitative method used in information systems (Myers, 1997). Clearly, the case study research is particularly well suited to information system research, since the object of the discipline is the study of information systems in organizations, where the research interest has shifted to organizational rather than technical issues (Benbasat, Goldstein, & Mead, 1987). A case study is, according to Yin (2002), an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2002). In a case study, the case may be a group of people, organization, process, or an information system. Since there is no standard definition of a case study, this thesis draws the definition from Benbasat, Goldstein and Mead (1987, p. 370):

“A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations). The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used”

Case study research is particularly appropriate for situations in which the examination and understanding of the context is important, such as areas where there is little understanding of how and why phenomena occur, and where the experience of individuals and the contexts of action are critical (Williamson et al., 2002). Since patients’ experiences and requirements of communicating with healthcare, as well as healthcare practitioners’ experiences of the availability of patient information and medical knowledge is not well understood, case study research is appropriate for this thesis. Case study research uses multiple data collection
techniques, such as interviews, observations, questionnaires, as well as document and text analysis.

Two case studies have thus been included in this thesis. These cases are compatible because they both deal with the availability of information, when and where it is needed by healthcare practitioners and patients.

3.3 CASE STUDY ONE

The case study “Future Healthcare Information Systems” aimed to develop a prototype visualization of a process support system (PSS) that demonstrates the requirements for future process-oriented information system support in healthcare. The vision for the process support system is that healthcare practitioners, from all levels of healthcare, and patients should have access to effective collaborative information systems that support process-oriented care in which the patient is a distinct and active collaborator.

The process support system was developed in close collaboration between researchers at the University of Skövde, a local hospital in the Västra Götaland region of Sweden, and healthcare organizations in the said region. The overall health care process is extremely complex and endeavoring to tackle it all within one project would clearly not be feasible. Therefore, one of the first tasks of the project was to select a suitable sub-process for the work to focus on. Some criteria were used for the selection. The chosen sub-process should:

- Be one where the patient can play an active role,
- Be relevant for more than one level of care (primary care, hospital care and municipality care) in order to demonstrate general applicability,
- Be relevant for more than one healthcare profession,
- Be complex enough, particularly in terms of information flow, to demonstrate a substantial difference between the existing way of working and the proposed future way of working, and
- Be frequent enough for the changed way of working to have a substantial impact on both healthcare practitioners and patients.

The project selected the process of initiating, planning, carrying out and following up a patient's visit to a healthcare provider. This process was termed “Patient Visit” and was limited to involve only ambulatory care. It is frequently occurring and exists both in primary and hospital care. Instances of the process in primary and hospital care also communicate with each other. Hence, it involves the desired element of complexity. Several professional groups are involved in the process and the patient needs to play an active role. Also, the chosen process was suitable to demonstrate the intricacies of the communication between a patient and healthcare providers. In order to be able to make the demonstrator concrete and illustrative, two scenarios of the “Patient Visit” process were chosen for implementation (see paper by Åhlfeldt et al., 2013).

3.3.1 INTERVIEWS, OBSERVATIONS AND PROCESS MODELING

The first step in the prototype development was to collect data regarding 1) how current information systems support healthcare practitioners in their daily work practice with regard to availability of information, and to a certain extent availability of medical knowledge, 2) how patients experience the exchange of information with healthcare providers, and 3) identify user requirements for future process-oriented information system support. For this purpose, two main activities were carried out in the project:
1. A current state analysis:

This activity was carried out in close cooperation with healthcare practitioners as well as patients from an orthopedic clinic. Additional information was gathered from the cardiologist, eye clinics, emergency units and primary care centers. The objective of this activity was to:

(1) explore and create a comprehensive picture of how current information systems support healthcare practitioners’ and patients’ information needs and (2) identify requirements for future information system support. For this purpose, interviews and direct observations were seen as adequate techniques for data collection (Berg, 2001b). Eighteen semi-structured interviews (see Appendix 1) and direct observations of healthcare practitioners were conducted. The observations of the healthcare practitioners lasted from a half to a full working day and involved visual inspection of their everyday work activities, observing what and how tasks were being carried out.

Moreover, the consultations and conversations that took place between the patient and the physician during the patient meeting were observed. In total, seven direct observations that lasted between 10 - 20 minutes were conducted. Each observation was complemented with a semi-structured interview, which made it possible to gain a deeper understanding of the data collected through the observations. The aim of the interviews was to study how patients perceive their patient process.

All interviews with healthcare practitioners and patients were taped, transcribed and analyzed (see section 3.5 for the qualitative data analysis), and lasted approximately two hours each. During the interviews, the interviewer took notes of the responses, which allowed the interviewer to highlight key points that needed further reviewing. All transcripts followed a standard format and included the following information:

- Date, time and place (city and type of healthcare provider, e.g., primary care) of the interview.
- The profession of the interviewee.
- To assure the interviewee anonymity, each interview was marked according to a coding system, e.g., VN550, whose code key was kept at a different location to the interviews, so that only the interviewer could identify the participants (Thomsson, 2010)
- List of acronyms (e.g., I = interviewee, and R = researcher, thus the interviewer).

An observation protocol was used to record information obtained during the observations of the healthcare practitioners and the patient meetings. A descriptive notes section for the description of activities was also included in the protocol (Creswell, 2007). In addition, the results from the observations and the interviews were discussed with the healthcare practitioners and the project team members.

The possibility of complementing direct observations with other techniques, such as interviews or questionnaires, is, according to Robson (2011), one of the main advantages of observation. Interviewing is a conversation for the purpose of gathering information about the context under study (Berg, 2001b). Conducting semi-structured interviews enabled, in advance, the predetermination of the ground to be covered and the main questions related to the patient meeting process to be asked. Although a list with predetermined questions was prepared, the interviewer was allowed the freedom to change the order of the questions or the way they were worded, in order to adapt to the flow of the interview and to explore issues deemed important (Berg, 2001b). The interview questions were organized according to a commonly used sequence, described by Robson (2011, p. 284) in figure 3.3.

Data obtained from the interviews and observations resulted in “As-Is” process models that described the patient meeting. These models helped to gain an overall picture of the business practice in the organization, and to describe how tasks are carried out during the patient meeting and what kind of information is needed to perform various work activities. The
models also helped to identify user requirements for the process support system. The process models have played an important role in the communication between the domain practitioners and the project’s researchers. Modeling business processes, or workflows, often plays a central part in the development of information systems, as well as the re-engineering of work practices (Krogstie, Sindre & Jørgensen, 2006).

The method used for modelling of the chosen process and for prototype development was the Visuera method. The method was chosen for the following reasons:

- The Visuera method is a process modelling method that enables modelling of activities and related actors in an organizational process. One particular feature of the method is that it integrates the flow of information with the activities in the process and also allows for the definition of concepts used in the process. Since the general focus of our research is to enhance the support that information can provide to healthcare processes, this was considered an important feature.
- The models produced with the method are fairly easy for non-experts to understand. Since an important part of the work was to have healthcare practitioners evaluate the feasibility of the proposed future process before it was implemented in the demonstrator, the aspect of usability for non-experts was considered to be essential.
- The method comes with a supporting tool that can take a graphical model describing a process and the related information flows and “translate” it into a simulation/demonstrator of how a system will work and how it will look, without actually implementing the system. Since the objective was to develop a demonstrator it was a reasonable choice.

The method consists of five steps:

1. Analyzing the As-Is processes. In this step current activities are documented in a graphical As-Is process model.
2. Specifying the requirements (To-Be). Here, components in the As-Is process models are identified, which have potential for being made more efficient. A To-Be process model is developed. Efficiency can be achieved by:
   i. Automating work currently being performed manually.
   ii. Removing manual or automated tasks that are without any significance for activities later on in the process.
   iii. Improving the quality of activities in the process.
   iv. Making sure that the end result of all activities has the highest quality.
   v. Improving throughput time by adding, deleting or reassigning tasks in the process.
   vi. Improving information quality in the processes
3. Developing a supporting information system if technological change is necessary, based on To-Be process models.
4. Deploying the new process and information system. In this step employees affected by the information system are educated.
5. Production and monitoring of improved processes and their support systems.

The Visuera method follows strict rules and has its own tool; the Visuera Business Process Modeler, which aims to ensure that process models have the same look and feel, regardless of organizational domain. The process models contain only a few symbols that intend to be intuitive. The process models can be abstracted or detailed into an unlimited number of levels. The prototype, presented in this thesis, got all of its sample data and flow logic directly from the process model. To increase the models’ accuracy, they were discussed with healthcare practitioners. It was important to make the models as generalizable as possible, so that they could be valid for several different healthcare units.
2. **Modeling of the intended future state:**

Based on the assessment of the current situation and the “As-Is” process models, work began on specifying the requirements of the proposed future state (To-Be models). Identification of the requirements began with an “idea seminar” with the project’s reference group. During this seminar, a number of “objectives” for the future state were identified. These objectives and the current state description of the first project activity formed the basis for a number of idea seminars/workshops with healthcare practitioners. During these seminars/workshops, practitioners were asked to discuss objectives and ideas about how an ideal process for the patient visit should work in the future and what type of information system support would be needed to accomplish the goals. A total of four seminars were held with approximately 15 to 20 people per session. The purpose of these seminars/workshops was thus to identify user requirements for the future state. Based on these requirements, the future patient meeting process was elaborated, in order to identify the sub-processes and information flows. Process models of the different sub-processes, comprising activities, roles, and information flows, were then created. An important part of this work was to identify the detailed contents of the information needed for the various activities in the process models. The information content was sketched in forms with the Visuera Business Process Modelling 2007 tool. Subsequently, the process models and the information content were validated by healthcare practitioners during workshop sessions, brainstorming meetings, seminars and lectures. Moreover, a patient representative from a patient organization provided feedback on the models.

### 3.3.2 PROTOTYPE DEVELOPMENT

Based on the identified user requirements and after a number of iterations to ensure the quality of the process models and the information content, key design principles for a future process oriented information system were identified. To visualize the key principles a prototype of a process support system was developed with several user interface screens. The resulting prototype was evaluated towards in relation to user requirements identified through observations, workshops and interviews. In addition to this, identified user needs were also evaluated against in relation to the Swedish national strategy for e-health and in seminars involving healthcare professionals, patients and information system providers. Based on this evaluation, the prototype was refined.

The findings of this case study have resulted in three published research papers:


I am the main author of this paper. I have had the sole responsibility of analyzing and summarizing the collected data. I have also had the sole responsibility of writing the paper. Feedback has been given by the co-authors.

**Paper 2:** Rexhepi, H., Åhlfeldt, R-M. & Persson, A. (2015) Challenges and opportunities with information system support for healthcare processes – A healthcare practitioner perspective. *Proceedings of the 8th International Conference on In-
CHAPTER 3 RESEARCH METHOD

I am the main author of this paper. For the purpose of this paper, I have had the sole responsibility to (1) analyze the data from the interviews and observations, and (2) write the paper. The process support system presented in this paper has been developed together with the co-authors.


I am an important contributor to this paper. I have had the sole responsibility for conducting the literature review. Moreover, together with the co-authors, I have been involved in developing the process support system presented in this paper. The paper has been co-written, meaning that the authors have had a joint responsibility for the writing.

3.4 CASE STUDY TWO

The “Knowledge repository project” was a collaborative endeavor between all the healthcare providers in Skaraborg, a sub-region of Västra Götaland, and the University of Skövde, Sweden. The aim of the project was to;

“Explore the possibility of creating a structured, resource-efficient and sustainable model for developing and managing a coherent IT-based knowledge repository for different areas of knowledge bases in healthcare. Coherent, means that there is one entrance to the knowledge the portal includes. Healthcare practitioners can use the knowledge portal to search and retrieve relevant knowledge”

Two studies were conducted within the frame of the project. The first study aimed at analyzing the characteristics and challenges of Swedish IT-based knowledge repositories containing medical knowledge. This study not only identified challenges that current knowledge repositories in Sweden are facing, but also the need for a comprehensive IT-based knowledge repository. Based on these results, the project continued with the implementation of the second study which aimed at exploring:

- How healthcare practitioners experience the availability of medical knowledge when and where they need it.
- What kind of medical knowledge is missing and/or difficult to obtain at the point of care, as well as how they would like to access that information.
• Conditions for developing a coherent IT-based knowledge repository for different areas of knowledge bases in healthcare.

3.4.1 INTERVIEWS

Within the first study, 15 IT-based knowledge repositories were included in the analysis. To collect empirical data, two data collection techniques were used: (1) inspection of the repositories according to predefined questions. This inspection aimed at collecting a variety of IT-based knowledge repositories at national, local and regional levels, which would demonstrate the multitude of approaches to creating knowledge repositories. The second method was: (2) telephone interviews with managers of the IT-based knowledge repository (see Appendix 2). Since telephone interviews lack face-to-face non-verbal cues that researchers use to pace their interviews and determine the direction in which to move, they are not regarded as a major way of collecting qualitative data (Berg, 2001b). However, in accordance with Berg (2001b), telephone interviews were an effective means of gathering data, owing to geographic locations (Berg, 2001b).

Within the second study, 62 semi-structured interviews were conducted with managers, nurses and nursing assistants from primary, specialist, and municipality care (see Appendix 3). A letter requesting participation in the research project was sent to managers within each municipality in Skaraborg, Sweden. A request was also sent to managers in primary care and to different units at specialist care in Skaraborg, Sweden. The letter contained requests to interview one manager, two nurses and two nursing assistants with varying experiences of working in the healthcare sector. Since the results from the first study showed that, the majority of the IT-based knowledge repositories had physicians as the main target group, they were excluded from this stage of the research study. The inclusion criteria also include factors such as different age range and gender. The managers then suggested one or two individuals who were willing to participate in the study. When the researcher started to gather information from one person, or several people, the researcher was then put in touch with others. However, there is always a risk with this type sampling. For example, there is a risk that managers only suggest practitioners who are familiar with KM and who will talk well about the organization. However, based on the analyzed data, managers have been successful in recommending healthcare practitioners who were willing to share the KM difficulties that the organization is experiencing. An equitable distribution of the professional roles that participated in the study has been sought. Unfortunately, it was not possible to achieve an even distribution between healthcare practitioners and managers at all three levels of healthcare, which could weaken the results (see figure 3.2). However, in the qualitative interviews, there is a condition known as theoretical saturation, which occurs when the researcher, through a series of interviews, can see a clear pattern, and when no new data appear. For the purpose of this work, we therefore believe that theoretical saturation was achieved at all three levels of healthcare. One can thus argue that the results are sufficiently reliable to answer the research questions 2 and 3.
Within the second study, two interview guides were developed; one for managers and one for practitioners, with associated questions based on the KM cycle/process, which means that the following aspects were addressed (see Appendix 3):

- Processes for capturing and creating knowledge.
- Processes for packaging, storing, sharing, applying and measuring whether knowledge has contributed to changes in the organization.

The practitioner interview guide also includes questions with regard to lack of medical knowledge in a clinical situation, for example, “What kind of knowledge do you miss most often? Why is this knowledge important for you?”

Interviews as the main data collection technique were thus used in both studies. There are different forms of interviewing. A commonly used typology distinguishes between structured, semi-structured and unstructured interviews. This can, according to Robson (2011), be linked, to some extent, to the depth of the response being sought. Using semi-structured interviews as the main data collection technique was appropriate, as I wanted to focus the interview around specific topics related to the availability of medical knowledge. The semi-structured interview is, according to Williamson et al., (2002), closer to the unstructured, in-depth interview, than to the structured, standardized form. This interview form is best suited when the researcher wants to capture and understand the respondent’s perspective on a situation or event under study (Williamson et al., 2002).

A set of questions were thus prepared beforehand in both cases, but as the interviews were intended to be conversational, the interviewer changed the order of the questions or the way they were worded, to adapt to the flow of the interview. The technique of “probing” recommended by Robson (2011) was used. This helped the interviewer encourage the respondent to provide more details to a response, i.e., to say more about a particular topic. Tactics, such as “Can you give me an example?” “Tell me more about that”, “Why was that important to you?”, were used. Additional unplanned questions were asked to follow up the answers (Robson, 2011). Moreover, the interview questions were organized according to a commonly used sequence, described by Robson (2011, p. 284) in the figure below.
The interviews from the first and second study were taped, transcribed (with pauses and all of the words spoken) and analyzed (see section 3.5 for qualitative analysis). The audio-taping of a research interview is a considerable advantage, as it provides a permanent record. The taping also allows the interviewer to concentrate on conducting the interview (Robson, 2011; Kvale, 1997). During the interview, the interviewer took notes of the responses, which allowed the interviewer to highlight key points that needed further reviewing. The transcription processes started by first listening to each interview and thereafter starting the transcription. In this way, it was possible to obtain a comprehensive understanding of the content of the interview. This approach also facilitated the transcription. When possible, the interview was transcribed on the same day as it was conducted. All transcripts followed a standard format and included the following information:

- Date, time and place (city and type of healthcare provider, e.g., specialist care, primary care) of the interview.
- The profession of the interviewee.
- To assure the interviewee anonymity, each interview was marked according to a coding system, e.g., VN550, whose code key was kept at a different location to the interviews, so that only the interviewer could identify the participants (Thomsson, 2010).
- List of acronyms (e.g. I = interviewee, and R = researcher, thus the interviewer).

The findings of this case study have resulted in three published research papers:


I am the main author of this paper. For the purpose of this paper, I have had the sole responsi-
bility for (1) analyzing the knowledge portals and carrying out the interviews, (2) analyzing the empirical data and (3) write the paper. Feedback has been given by the co-author.


I am the main author of this paper. I have had the sole responsibility for (1) collecting and analyze the data (2) write the paper. Feedback has been given by the co-author.


I am the sole author of this paper. I have had the responsibility to collect and analyze the data that is presented in this paper.

### 3.5 QUALITATIVE ANALYSIS

The analysis of the empirical data has been conducted with inspiration from the Grounded Theory research method. Grounded theory analyses are especially suitable when the research attempts to understand the nature of the studied object (Sharan, 1988). Since this work, seek to describe how practitioners experience the availability of patient information and medical knowledge, as well as how patients experience the information exchange with healthcare providers, grounded theory analysis was considered suitable, due to its ability to produce a rich, deep description of people’s experiences. The aim of the analysis was to find central core categories which, according to Robson (2011), are both at a high level of abstraction and grounded in the collected and analyzed data. This was achieved by carrying out two kinds of coding: open coding and axial coding.

Open coding is the first step of the analysis that pertains to the initial discovery of categories and their properties. This first step of open coding started by reading through the transcribed interviews several times, in order to create a deeper understanding of the respondents’ statements. The actual coding then started. The open coding of the transcribed data has involved the line-by-line coding of words and phrases through the use of highlighting (Strauss & Corbin, 1990). Each word or phrase was assigned a concept noted in the margin. An example of a concept that was identified is “support in decision-making”. At this stage, the coding was conducted directly in the word document program, by using the “insert comment” function (see figure 3.4). When all the concepts had been identified, they were grouped into border categories. An example of a category that relates to the above concept is “information explosion”. Moreover, to obtain a better overview of the data, phrases and/or words already marked with the associated concept were transferred to an excel sheet. In order to identify the categories, the concepts and the phrases and/or words related to the specific concepts were closely examined and compared for similarities and differences, while constantly questioning the data with the neutral inquiry; “what does this indicate and how
does it relate to other concepts?" The open coding together with the questions asked are the basic grounded approaches to the data and will, according to Glaser (1992), lead to emergent discoveries.

Axial coding involved further exploration of the categories and concepts that were developed in the process of open coding (Oktay, 2012; Strauss & Corbin, 1990). It was the process of identifying the relationship between and within the categories. Furthermore, axial coding provided depth to the description of the identified concepts, which evolved into a deep understanding of, e.g., how practitioners experience access to information in the patient process and how patients experience information exchange with healthcare providers. It also gave a deeper understanding of the difficulties practitioners experience with regard to availability of information and how they want future information systems to support their work practice and thereby improve the quality of care delivery.

Consider the following example where categories are related to each other. When analyzing the transcribed interviews that were conducted as part of the second case study, two major categories which are critical to knowledge management work in an organization were identified, namely, "people’s interest in knowledge searching" and "a dedicated manager". The comprehensive analysis of these two categories clarified the relationship, i.e., if managers are not personally committed to learning or do not regard sharing and using best practice as critical parts of the quality of care, the attitudes of the managers effect people’s interest in KM activities.

Throughout the analysis, “memo-writing” was used to record the researcher’s thoughts about the meaning of codes, as well as how and why they occurred. Memos were also used to clarify the relationship between categories, and to systematically question ideas in relation to what had been said in the interviews (Sbaraini, et al., 2011; Glaser, 1992).

As this thesis is concerned with exploring and describing the phenomena under study, the open and axial coding of grounded theory completed the interview analysis. The conclusion is supported by Robson (2011) who argues that open coding and axial coding complete the analysis, if the aim of the research is not to develop a theory. Otherwise, one must proceed with the third step of the coding, namely, selective coding.

3.6 GOOD RESEARCH PRACTICE

This work is based on empirical data collected via semi-structured interviews and observations. According to (Robson, 2001), ethical issues lurk in any research involving people. Therefore, the researcher should consider ethical principles when planning and conducting research. Central to ethical principles is the idea of informed consent, "the right to be informed”. Within this work, all respondents were informed about the research subject, the
nature of the research, as well as that participation is voluntary and they can withdraw at any
time. Each respondent in the two case studies confirmed his or her willingness to participate
after having been informed of all aspects of the project, e.g., the aim of the project, how data
will be processed and how confidentiality will be maintained.

The respondents were also informed that the interviews would be recorded and transcribed,
to which they were required to give their consent. In addition, the respondents were in-
formed about the approximate length of the interview, how to contact the researcher later, if
they had any questions, who would be given access to the transcribed interviews, and how
the interviews would be analyzed. In this case, the respondents were informed that only re-
searchers from the project would have access to the interview material. Moreover, they were
informed that their comments may be used as quotes, but only with their consent and with-
out the possibility of linking the comments to the respondent. Just as in the interview stud-
ies, participants in the observation studies were given information about the aim of the re-
search, how the observations are related to the interviews and exactly what the researcher
intends to observe and analyze (Vetenskapsrådet, 2011).

“Giving anonymity and confidentiality to participants when reporting on research is the
norm” (Robson, 2011, p.207). The Swedish Research Council (Vetenskapsrådet, 2011) stress-
es the importance of researchers taking measures to protect respondent’s integrity. To pro-
tect integrity and the right to their private life, the interview recordings, the transcribed in-
terviews and the notes from the observations were kept safe and only made available to
those researchers involved in the studies. Additionally, to assure the respondents’ anonymi-
ty, each interview and observation was marked according to a coding system, e.g., VN550,
whose code key was kept at a different location to the interviews, so that only the interviewer
could identify the respondents (Thomsson, 2010).

3.7 THE TRUSTWORTHINESS OF THE
RESEARCH

Qualitative researchers strive for “understanding” the knowledge that comes from personally
visiting participants in their field, and from probing to obtain meanings (Creswell, 2007).
During and after a study, qualitative researchers ask; “did we get it right?” or “did we pub-
lish an inaccurate account?” (Creswell, 2007, p. 201). To answer these questions, the trust-
worthiness of the research is discussed on the basis of the concepts: credibility, dependabil-
ity, transferability and conformability.

3.7.1 CREDIBILITY

The credibility criterion concerns whether the results are credible or believable, from the
perspective of the participant in the research. This criterion corresponds to internal validity
in quantitative research (Lincoln & Guba, 1985). To increase credibility in the FHIS project,
different techniques for data collection, such as observations, interviews and process model-
ing, were used. The use of these various techniques made it possible to capture different di-
mensions of the same phenomenon. To test our interpretation, participants provided feed-
back on the collected data. For example, the business models were continuously discussed
and corrected, after feedback from participants.

Credibility can also be discussed within the frame of the Knowledge repository project, with-
in which two studies were conducted. The first study aimed at analyzing a number of Swe-
dish IT-based knowledge repositories. For this study, telephone interviews were conducted
with managers of the repositories. To increase credibility, respondents that participated in
the telephone interviews were given the opportunity to provide written feedback on the con-
cussions drawn from the interviews. Unfortunately, only a few took the opportunity to do so.
However, before the conclusion of each interview, the interviewer orally summarized the in-
terview, in order to test interpretations and conclusions. In this manner, the respondent was given the opportunity to correct any misunderstandings. During the second study, healthcare practitioners and managers were interviewed. Unfortunately, the data collected from this study were not validated with the respondents, which may be a limitation. The conclusions from the study were, however, discussed with the project participants with insight into the different levels of healthcare.

3.7.2 DEPENDABILITY
Dependability is a criterion which is considered equivalent to reliability in quantitative research. It is concerned with the stability of the results over time (Lincoln & Guba, 1985). Dependability can, according to Lincoln and Guba (1985), be enhanced by using overlapping methods and inquiry audits. In order to guarantee dependability, interviews were recorded and transcribed in their original language. Overlapping methods have been used in the FHIS project, which has strengthened dependability. By submitting the results from the FHIS project and the Knowledge repository project to peer reviewed conferences, the research process and the research results have been verified by an outside expert “auditor”.

3.7.3 TRANSFERABILITY
Transferability can be enhanced by providing a thick description of the research domain and the research results (Brown, 2005). We have sought a detailed description of the two empirical studies, so that the readers can decide for themselves whether the results are transferable to their own contexts. However, we argue that parts of the results from the FHIS project can be generalized to other healthcare organizations outside Sweden. For example, the challenges identified in case study one are problems faced by healthcare organizations worldwide. Furthermore, we believe that the challenges identified in the Knowledge repository project are not unique to the healthcare sector and can therefore be generalized to other domains.

3.7.4 CONFORMABILITY
Conformability concerns whether the interpretations are based on the collection of data. Strategies such as recorded interviews and field notes can enhance conformability, since recorded data can be reviewed and examined (William, 2006). These two strategies have been used in this work. Through record keeping, the researcher has been able to recheck the data throughout the study. Furthermore, the transcribed interviews with associated memos facilitated the review of the identified categories. By using these strategies, conformability has been enhanced.
CHAPTER 4
RESULTS

This chapter provides a brief summary of each research paper, focusing on aims and conclusions drawn. In total, 6 research papers serve as the foundation for this thesis. The papers relate to different research questions and they all respond to the aim of this thesis. Figure 4.1 presents an overview of how each of the research papers contributes to the research questions.

Figure 4.1: Relations between the included research papers and the research questions
4.1 Patients’ Experiences of Communicating with Healthcare - An Information Exchange Perspective

Paper 1 aims to explore how patients experience information exchange with healthcare providers and how this relates to the six areas that constitute good quality care. This paper is based on case study one and the main results are:

- When seeking care for medical problems patients reported experiencing gaps in information exchange among their providers and between themselves and their providers.
- Patients often felt that physicians did not offer information that was matched to their needs.
- Patients often felt that physicians did not listen to their perception of their own illness.
- Patients commonly left their appointments feeling confused, unable to recall what had been discussed, or simply missed information about their conditions and treatments.
- Communication difficulties and missed information left gaps in patients’ knowledge about their current health condition and prognosis.
- Gaps in information exchange forced the patient to take a great responsibility in communicating their health information to different providers. Therefore, much of the patient’s time was spent on locating and communicating information between healthcare practitioners, despite being ill or injured.
- Patients felt that they are not given the opportunity to influence their own patient process.
- Deficiencies in information exchange between healthcare practitioners and patients prevent the fulfillment, to the extent that is possible, of the six areas that constitute good quality care.

The conclusions in paper 1 state that Swedish hospitals demonstrate good medical outcomes, but that unfortunately there are still far too many patients who do not receive care in a timely manner and who are not given the opportunity to participate and influence their healthcare. When the exchange of information does not function properly, patients’ health status is also affected. The efficient exchange of information between healthcare providers and patients is therefore a key issue for creating the best conditions for good quality care and to give patients a sense of empowerment.

4.2 Challenges and Opportunities with Information System Support for Healthcare Processes – A Healthcare Practitioner Perspective

Paper 2 is based on case study one and aims to (1) explore how healthcare practitioners in Sweden experience information system support in their daily work practice, and (2) present and illustrate how key design principles of a process support prototype can support
healthcare practitioners in performing their work activities and increase patient engagement.

To understand current information system support a current state analysis was first conducted, involving both healthcare practitioners and patients. Observations and interviews with healthcare practitioners, healthcare administrators, patients and patient organizations, process modelling and workshops involving professionals from a broad range of disciplines, were the main research activities.

The study findings confirm that healthcare practitioners lack access to patient information when preparing and conducting patient visits, as well as when making decisions about the care of the patient. Lack of patient information resulted in inefficiency problems, unnecessary waiting times for patients, and inefficient workflows. For example, during the observation studies, it was apparent that before a patient encounter a physician had to access several information systems, in order to obtain an overview of the patient’s medical history. Although a number of different systems were used, the physician could never be sure that he/she had a clear and complete picture of the patient. In the absence of this information, a complex set of patient flows emerged during which practitioners had to spend valuable time on locating and collecting relevant patient information.

In accordance with current research, the study findings also confirm that unstructured information in the EHR is a challenge for healthcare practitioners. As the information in the EHR is recorded as free text, without limitations to the format or structure, reviewing them manually was regarded as time-consuming. The unstructured format also made it difficult for practitioners to extract important information. Another issue relates to terminology. One doctor may have one background and training, whereas another doctor has another background. Hence, they document differently and use different terminologies. Consequently, there is a need to “rationalize” the data – render the terminology into standard sets of terms. Lack of coordination of patient care was also identified as a major problem affecting the care of patients. Interoperability issues were considered to be one of the reasons. Another reason was the functional organizational structure of task specialization, resulting in lack of care coordination. Lack of interoperable information systems and the absence of the electronic booking of treatments and examinations complicate the situation even more. Moreover, a recurring problem experienced by the healthcare practitioners was related to the care request/referral process. The problems are based on the following: (1) it is not possible for healthcare practitioners or patients to electronically fill in and send a care request, and (2) incoming care requests from primary care usually lack important information. Referrals that did not include the required information were always sent back. This is, according to the healthcare practitioners, one of the reasons why patients do not receive care within a reasonable period of time.

To address the above challenges, a prototype for a process support system was developed. The vision for the process support system is that healthcare practitioners and patients should have access to efficient collaborative information systems that supports a process-oriented care where the patient is a distinct and active collaborator, meaning that:

- Appropriate parts of the process support system are available to both patients and practitioners, and take into account usability for different user groups.
- The involved roles/users interact through the process support system. The underlying approach is process oriented.
- Various relevant individual information systems interact with patients and practitioners through the process support system.

The demonstrated process support system is not a new information system that aims to replace an existing one. It is a process support system that can be viewed as a layer of abstraction or user interface above the various individual information systems, enabling the
enactment of the process and interaction between patients and practitioners through computers and mobile devices, without accessing each individual information system. The process support system drives the process forward, ensuring that it is carried out properly and, hence, supports users in performing work activities. The process support system provides thus a user interface to the various systems involved in performing a task. The principles of the process support system are described in the paper by Åhlfeldt, et al. (2013) and in figure 4.2.

Figure 4.2: The principle of the PSS (Adapted from Perjons et al., 2005)

The architecture of the process support system makes it possible, at least in theory, to replace individual IT systems without significant effect on the user. The process support system connects the following aspects:

- Access to relevant patient information, both medical and administrative.
- Process control providing integrated support for the user.
- Access to relevant medical knowledge through integration of medical guidelines and an IT-based knowledge repository.

The conclusions in paper 2 confirm that a process support solution, such as the one described in this paper, creates new opportunities to organize and coordinate healthcare. The process support system focuses on the patient process and the information flows within this process. For healthcare practitioners, the process support system solution improves the availability of patient information in a uniform and transparent way, anywhere and anytime, as required by the patient process. The process support system reduces double documentation and the manual handling of information, which in turn reduces the risk of making errors. Since healthcare practitioners no longer need to spend time on locating patient information, more time can be spent on meeting patients. However, much work remains before a process support system, such as the one presented in this paper, can be fully implemented. For example, there is a need to render the terminology into standard sets of terms and to determine the ownership and responsibility of a process support system that crosses organizational boundaries and supports patient-centered care. Another challenge regards who would be responsible for the ownership and the quality of the process data.

4.3 WEB-BASED KNOWLEDGE PORTALS IN SWEDISH HEALTHCARE – OVERVIEW AND CHALLENGES

Paper 3 is based on case study two that aimed to explore the possibility of creating a structured, resource-efficient and sustainable model for developing and managing a coherent
CHAPTER 4 RESULTS

IT-based knowledge repository for different areas of knowledge bases in healthcare. The goal of this paper was to report on an analysis of a representative number of Swedish IT-based knowledge repositories. The analysis resulted in the identification of several challenges:

- IT-based knowledge repositories are usually designed to support specific functions and particular target groups with particular needs of medical knowledge.
- Knowledge from IT-based knowledge repositories is usually infrequently available in a form that can be acted upon at the time decisions must be made. The knowledge is often structured in a hierarchical and linear manner comparable to that of a book or report. When a large amount of information is presented to the user at once, it can lead to confusion and complicate the filtering of unnecessary information. In turn, it can lead to difficulties in managing situations that require choices to be made. Also, this type of structure focuses on gathering information rather than on learning. This problem emphasizes that future IT-based knowledge repositories need to be developed using a governing method that structures knowledge in a suitable way.
- Current IT-based knowledge repositories do not support the exchange of clinical expertise.
- There is a lack of processes and resources in place for maintaining IT-based knowledge repositories.

The conclusions in paper 3 confirm that IT-based knowledge repositories are becoming more and more common in modern healthcare, not only in Sweden but throughout the world. They have the potential to contribute to both prevention and treatment of health problems, by supporting both healthcare practitioners and citizens with medical knowledge when and where they need it. However, in order for IT-based knowledge repositories to live up to expectations, a number of challenges need to be addressed, of which some have been discussed in this paper. The issues addressed in this paper have an impact on the development and the survival of IT-based knowledge repositories over time.

4.5 WORLDS APART – IT STRATEGIES FOR EVIDENCE BASED MEDICINE MEETS REALITY

Paper number 4 is also part of case study two and aims to (1) explore how primary, secondary, and municipality care in Sweden work with the process of managing knowledge, (2) explore how healthcare practitioners experience the availability of medical knowledge when and where they need it and (3) study conditions for developing a coherent IT-based knowledge repository for different areas of knowledge bases in healthcare.

The following main issues were identified within this study:

- Healthcare practitioners lack access to evidence based medical knowledge when preparing and conducting patient visits, as well as when making decisions about the care of a patient. One of the main reasons is that the participating organizations have failed to embed the KM process in everyday processes. It is evident that the processes and information flows are not understood and documented.
- The main barrier hindering the adoption of KM is related to people and organizational culture. For example, lack of effort, interest and skills needed to search for medical knowledge among the massive volumes of research being produced was common. The organization has also failed to establish a tacit knowledge-sharing culture and to build a working environment that encourages the sharing of knowledge.
Practitioners lack access to adequate IT-support for accessing and sharing medical knowledge.

To simplify access and ensure the application of knowledge that guides practitioners in delivering good quality care, practitioners expressed an urgent need to integrate medical guidelines and other relevant medical knowledge sources with EHRs. There is also an urgent need of IT that supports the sharing of tacit knowledge between practitioners within and outside the organization.

As the main KM problems are related to people and organizational culture, a coherent IT-based knowledge repository should not be developed at this stage. Instead, it seems more relevant that the participating organizations focus on the systematization of their KM processes.

### 4.6 SUPPORTING ACTIVE PATIENT AND HEALTHCARE COLLABORATION - A PROTOTYPE FOR FUTURE HEALTHCARE INFORMATION SYSTEMS

The aim of paper 5 is to present and illustrate the main features of a proposed process-oriented approach for patient information distribution in future healthcare information systems, by using a prototype of a process support system. The vision for the process support system is that healthcare practitioners and patients should have access to effective collaborative information systems that support process-oriented care in which the patient is a distinct and active collaborator. To achieve the vision, a healthcare process that is repeated throughout the healthcare system and can demonstrate patient / healthcare communication, i.e., initiating, planning, carrying out and following up a patient’s visit to a healthcare provider, was selected. This process was termed “Patient meeting”. To demonstrate how a process-oriented information system can support an active patient and improve healthcare collaboration, seven key design principles for the process support system were identified.

Some of the key design principles are the following:

- **The patient processes is in focus**: The process support system focus on the patient process through healthcare and on the information that is needed during this process, making sure that practitioners always have easy access to patient information; both medical information (e.g. medical records, lab-results, medical list) and administrative information (e.g. appointments) in a timely manner. The process support system also supports the patient’s need for information and engagement. For example, the patient can send in an electronic care request to primary and secondary care, and book appointments with doctors online.

- **Shared goals for the patient visit**: In order to ensure that healthcare practitioners take into account the patient’s expectations of the patient visit, the process support system provides an opportunity for patients to state their expectations beforehand.

- **The process support system is based on standardized information**: To improve the availability of information, it is essential that the information is standardized and structured. To achieve this requirement in the process support system, the information content of the national quality registers for selected diagnoses has been used. The different types of information stored in quality registers have been transformed into checklists for each diagnosis.

- **Efficient information flows**: By adopting a process-oriented approach the information flows can be more efficient. The process support system can ensure that patients and practitioners always perform the correct activities during the differ-
ent parts of the patient process. A major advantage of a process-oriented approach and tools to support the process is that the process support system drives the process forward. When a task is completed, it will initiate and show nearby activities. For example, when a healthcare practitioner in specialist care have written and signed the final documentation for the patient record, the process support system automatically picks up the form "response to care request" that will be sent back to the physician in primary care.

- **Digital booking and coordination of patient treatments and examinations**: The process support system enables electronic booking and coordination of treatments and examinations. It is also possible to follow the status of these activities. If some activities, such as, e.g., laboratory tests, are not completed before the scheduled patient visit, then this visit can be cancelled in advance. In this way one prevents the patient to come to unnecessary meetings.

The main conclusions of paper 5 are the following:

- A visualized prototype is a suitable tool for illustrating both the opportunities and constraints of future ideas and solutions in eHealth.

- A process support system, such as the one described in this paper, can provide many advantages for healthcare practitioners and patients. However, technical and organizational/management challenges need to be managed before a fully functional process support system can be developed and implemented.

Examples of challenges that have been identified are:

- The interfaces between the process support system and the underlying IT-systems need to be developed. This is especially important, as concepts are frequently defined and written in different formats. However, it is not just a question of making this technically possible; it is also a question of information quality.

- One of the main challenges relates to the ownership and management of the process support system that crosses organizational boundaries and supports patient-centered care, such as solving who owns all process data generated in the process support system, who takes responsibility for the quality of the process data, who will be the process owner of the entire patient process? If the technical challenges can be solved, then this will be the biggest challenge for implementing the process support system.

### 4.7 SUPPORTING EVIDENCE BASED MEDICINE – A PROTOTYPE FOR FUTURE HEALTHCARE INFORMATION SYSTEMS

The aim of this paper is to present and illustrate how a prototype visualization of a process support system that was developed within case study one can support the availability of relevant medical knowledge in a way which is seamlessly integrated with healthcare practitioners’ work practice, and thereby enables healthcare practitioners to work in accordance with EBM.

The study results confirm that a process support system can reshape the practice of EBM, by making relevant medical knowledge available to those who need it and where they need it. An important key solution to the problems identified in papers 2, 3 and 4 is to view patient information and medical knowledge as interconnected, such that they continually impact on each other. This solution is based on the assumption that relevant medical knowledge, such as medical guidelines, can be derived from previously entered patient data. In this manner, we can ensure that healthcare practitioners always have access to relevant and the best explicit scientific medical knowledge, when and where they need it. Sub-
sequently, since EBM also includes clinical expertise, an IT-based knowledge repository is integrated into the process support system. An IT-based knowledge repository can thus facilitate the sharing, creation and capture of new knowledge.

Before we try to support EBM by means of a process-oriented information system, we must be aware of the challenge related to organization specific consensus. Since the guidelines for good medical practice exist at national, regional, and local levels, contradictions between the guidelines exist. Hence, a crucial challenge will be to agree on which medical guidelines should be implemented within the process support system. Another challenge relates to the responsibility for the ownership and the quality of the medical knowledge within the process support system and within the IT-based knowledge repository.
CHAPTER 5
SYNTHESIZED RESULTS

This chapter aims to present recommendations for the development of future healthcare information systems, which are derived from the included research papers. Hence, these recommendations constitute the final step towards answering research question 5. These recommendations aim to support healthcare managers, IT-managers and system developers in the development of future healthcare information systems, from a process-oriented and knowledge management perspective. By following these recommendations, it is possible to develop information systems that facilitate the practice of evidence based medicine, and improve patient engagement.

5.1 FUTURE IS SHOULD SUPPORT THE PRINCIPLES OF EVIDENCE BASED MEDICINE

Future healthcare information systems must support the three elements of EBM in an integrated manner and neither one alone is enough. This means that healthcare information systems must contribute to improving healthcare quality and safety, by giving healthcare practitioners access to both up-to-date patient information and relevant medical knowledge in an integrated manner and at the point of care. Following the principles of EBM, healthcare information systems must also enable patients to access, utilize, and share their health information electronically. The following sections describe the conditions that an information system requires in order to support the principles of EBM.

5.1.1 A PROCESS-ORIENTED APPROACH, WITH SUPPORTING INFORMATION SYSTEMS

An evidence based practice requires the exchange of patient information between healthcare practitioners from different disciplines and units. To support a cooperative work process among healthcare practitioners and units, patient information must be accessed by practitioners in a standardized and transparent way, anywhere and anytime. However, one of the greatest challenges currently facing healthcare organizations is interoperability issues. To achieve a seamless and secure transfer of information between practitioners, a more process-oriented approach, with supporting information systems, must be considered. A process support system, as the one presented in paper 5, focusing on the patient process, is one step towards that direction (Åhlfeldt, et al., 2013). A process-oriented approach is thus an important foundation for achieving a system design that focuses on the care process from the patient’s perspective and thereby sets the core process, i.e., the pa-
tient process, into focus (Åhlfeldt et al., 2013). This approach is also important as it focuses on the results of the process, e.g., to provide good quality care (Rentzhog, 1998). The process-oriented approach can streamline the flow of information and, with support from a process support system, we can ensure that healthcare practitioners always have access to the right patient information, when and where they need it. However, for information to be a usable resource in the long term, it must have a standardized, nationally established structure. Information must therefore be placed under a common regulatory framework and form part of a uniform information structure (Ministry of health and social affairs, 2006). This will allow different information systems to manage and exchange information more efficiently and securely.

5.1.2 IMPROVE PATIENT ENGAGEMENT THROUGH PROCESS-ORIENTED INFORMATION SYSTEMS

Patient engagement is, according to Carman et al., (2013, p. 224), characterized by the amount of information shared between patient and provider and how active a role the patient has in health decisions. Patient engagement is also recognized as a key component in improving patient safety (Longtin et al., 2010). Without the efficient exchange of information between healthcare providers and patients, patients are not able to participate and be engaged in their own healthcare. However, patient engagement not only concerns giving patients access to health information, it is also about engaging the patient in decision-making, enabling the patient to contribute with health information (e.g., electronically fill in a health declaration) and increasing their possibilities to communicate their expectations, values and preferences.

Since there is a growing body of evidence showing that patient engagement offers a promising pathway toward better quality healthcare, more efficient care, and improved population health (see, e.g., Carman et al., 2013; Hibbard & Greene, 2013), future healthcare information systems must also be developed from a patient perspective. Patient engagement can be improved if a process-oriented approach with supporting IT-systems is adopted. As this approach has a customer perspective, future healthcare information systems must be more process oriented, from the perspective of the patient process, and more patient centered.

An example of how patient engagement can be improved is presented in paper 5. This example is based on the idea that a process support system can change the traditional patient-model in which practitioners determine when, where and what type of care to offer the patient, by allowing the patient to become a distinct and active collaborator. A patient can become a distinct and active collaborator only when he/she is given easy access to information about their own care. As patient engagement is also about enabling patients to take responsibility for their healthcare, they should be able to electronically submit health information by, e.g., filling in a health declaration and by making their own appointments. To help patients gain control over their care process, future information systems must also be able to display what the next step in the process is supposed to be. Furthermore, in order to ensure that patients’ expectations, values and preferences are captured before a doctor visit, the patient should be able to submit this information electronically.

However, it must be stressed that an information system can only facilitate patient engagement. It is healthcare practitioners’ beliefs, attitudes and behavior that have a major effect on patient engagement (Longtin, et al., 2010). Therefore, it is essential for organizations to discuss issues, such as “how they perceive patient engagement, as well as advantages, obstacles, barriers to patient engagement, and how to encourage patients to participate”. Only then can process-oriented information systems be used to their full potential.
5.1.3 OFFER NOT ONLY CURRENT INFORMATION, BUT ALSO RELEVANT INFORMATION ACCORDING TO THE PATIENT PROCESS

Having access to information about the patient at the right time is an important element of EBM. To ensure an evidence based practice, clinical questions must be addressed at the moment they arise. Therefore, future healthcare information systems should not only present up-to-date patient information to healthcare practitioners, but also offer relevant information, according to the current context. Consequently, an important question to be answered is how to determine what relevant information is. The question can be answered by focusing on the type of information required within an episode of care and for a specific illness or diagnosis.

In addition, the practice of EBM can be supported by bringing medical knowledge to the point of care. Having access to relevant medical knowledge at the right time can mean the difference between an accurate or erroneous diagnosis and treatment. Although medical knowledge guides decisions about the care of an individual patient, this information is today separated from patient information. This implies that the standard KM approach for knowledge dissemination in healthcare organizations are the access approaches to stored information, e.g., access to information that is stored on the intranet and/or in IT-based knowledge repositories, etc. Although such approaches are necessary, they are not always sufficient. For example, if a physician is documenting in an EHR and has questions regarding a specific diagnosis, the physician must use a different information system to find the relevant medical knowledge. Therefore, a potential solution to this problem is to extend the KM approach in healthcare so it goes beyond the traditional form of disseminating knowledge through documents and unstructured information stored in distinct systems.

Ideally, medical knowledge, such as medical guidelines, should be embedded within a process support system. In addition, recommendations derived from medical guidelines should also be reflected in reminders. Consequently, practitioners would not have to explicitly look for guidelines, and therefore possibly avoiding the risk of missing important medical knowledge (Lenz & Reichert, 2007).

To ensure that only relevant knowledge is made available, the knowledge-sharing solution should be carried out in two stages. In stage 1, medical knowledge, such as medical guidelines, should be matched with unique patient information within a process support system. Medical guidelines can thus be derived from previously entered patient data. In this case, the medical knowledge is more focused, thus case-specific and structured. Stage 2 should provide a more holistic knowledge view that is related to the documented patient information. This can be achieved by integrating an IT-based knowledge repository into a process support system. This knowledge-sharing solution suggests that patient information and medical knowledge should not be regarded as two separate aspects. Instead, they must be viewed as interconnected, such that they continually impact on each other. This solution is presented in detail in paper 6.

5.1.4 FUTURE INFORMATION SYSTEM SHOULD ENABLE A COMBINATION OF ACCESS, COMMUNICATION, CREATION AND CAPTURE OF MEDICAL KNOWLEDGE

The traditional view of KM in healthcare, regarding the dissemination of knowledge, is thus the access approach. This view emphasizes knowledge access, but not the exchange of experiences and the creation of new knowledge, which are important parts of EBM. Therefore, to support healthcare practitioners in their practice of EBM, IT-based knowledge repositories should not only (1) be integrated within the process support system, in order to provide a single integrated point of access, (2) provide access to more structured explicit medical
knowledge, but also (3) include the communication perspective. This has been found to be important, since explicit medical knowledge on its own is not sufficient for making decisions. Even tacit knowledge is considered to have a strong influence on medical decision-making. Therefore, the current traditional view of IT-based knowledge repositories must evolve from simply being the one-way retrieval of information to becoming a two-way system that provides collaborative and exchange features. Informal online discussion forums, knowledge cafés, and communities of practice (CoPs) are examples of collaborative and exchange features. These features can be made available via an IT-based knowledge repository that is integrated into a process support system. By including collaborative features, healthcare practitioners can share their clinical expertise (this solution is presented in detail in paper 6). For example, during a patient encounter, the patient informs the physician about particular side effects of the drug Venlafaxin 20 mg that he/she has experienced. The doctor prescribed the drug to the patient 8 months previously, after consulting the medical guidelines. The physician, who has prescribed the same drug to patients for more than 20 years, has never heard of these particular side effects. Therefore, the doctor turns to the discussion forum in the IT-based knowledge repository that is integrated into the process support system. In the discussion forum, the physician seeks advice from colleagues about the problem, by presenting a question. Practitioners from local, regional and national levels with experiences of the topic respond by offering their knowledge of the problem. A debate ensues between practitioners who share and discuss their clinical experiences, scientific papers and theories (Abidi, 2007). Based on the discussion, important conclusions are drawn that help the physician in the decision-making. Although the knowledge that is shared in the discussion forum is not evidence based, it can, according to Abidi (2007), still have a high trust value, as it originates from colleagues. The knowledge that is created in the online discussion forum can be captured (if relevant) to explicit knowledge, which can then be packaged, stored and shared through the knowledge repository, or be integrated as a guideline in the process support system. However, to ensure the creation, identification and use of new knowledge, the KM process must be integrated into organizational processes (see section 2.7). There must also be well-defined rules governing what knowledge should be captured and stored, who should be responsible for capturing new knowledge, who should be responsible for reviewing the quality of the captured knowledge, as well as how it should be packed and stored (Persson, Stirna & Aggestam, 2008). Furthermore, the enablers of the KM process must also be considered (see section 2.7).

Additionally, if an IT-based knowledge repository is to be integrated into an information system, whether it is a process support system as the one described in this thesis or an EHR, deciding which level (local, regional or national) the repository should be at and who should be responsible for keeping it up to date is essential.
CHAPTER 6
CONCLUDING REMARKS AND FUTURE WORK

This chapter summarizes the main findings of this work and its contributions. It also presents future work.

6.1 REVISITING THE RESEARCH QUESTIONS
To achieve the aim of this thesis, five research questions have been formulated.

The first research question is: What are the problems with the availability of up-to-date patient information, from the perspective of patients? As shown in paper 1, the answer to this research question is that patients experience gaps in information sharing among their providers and between themselves and their providers. Gaps in the exchange of information force patients to take a greater responsibility in communicating their health information between different providers. Therefore, much of a patient’s time is spent on locating and communicating information between healthcare practitioners, despite being ill or injured. The study results also confirm that patients commonly leave their appointments feeling confused, unable to recall what had been discussed, or simply missed information about their conditions and treatments. Many patients also feel that physicians usually do not offer information that is matched to their needs, or suited to their individual ability to absorb information. Communication difficulties and the lack of information leave gaps in patients’ knowledge about their health status and about their future. Without adequate information, patients also feel that they are not able to successfully engage in their own care. Inadequate information also results in feelings of uncertainty and insecurity. The results also confirm that patients often feel that physicians do not listen to their perception of their own illness. In addition, they feel that they cannot participate and influence matters affecting their health, for example, they cannot influence appointments for doctor visits.

The second research question to address is: What are the problems with the availability of up-to-date patient information and relevant medical knowledge when and where it is needed, from the perspective of healthcare practitioners? This research question is based on empirical data collected from two case studies. As shown in paper 2, information systems that support a seamless flow of information along the patient processes are not broadly used in healthcare environments. Usually, healthcare organizations have their own autonomous information systems that do not support cooperation between different organizational units and medical disciplines. Consequently, vital information (both medical information about the patient and administrative information) stored in these systems can-
not be easily accessed, in order to present a clear and complete picture of the patient at the point of care. Healthcare practitioners perceive the situation as worrying, as seamless and shared care requires a high level of interoperability and information sharing among practitioners involved in the care of a patient. Interoperability issues not only hamper access to patients’ information, they also result in inefficiency problems, unnecessary delays for patients, and inefficient workflows. In addition to the issues with current information systems, it has also been found that the functional organizational structure complicates the coordination of care. For example, when each practitioner only focuses on their own functions, they usually fail to communicate critical elements of care to the receiving unit.

When analyzing the empirical data from case study 2, it was found that healthcare practitioners had major difficulties in practicing EBM, as they lacked access to relevant explicit medical knowledge when making decisions about the care of a patient. Insufficient time for searching and capturing knowledge is one of the difficulties. This is due to the fact that medical knowledge is not integrated with clinical workflow. Other difficulties include not knowing where to search for relevant knowledge. This problem stems from the principal shortcomings of EHRs and IT-based knowledge repositories. First, IT-based knowledge repositories are located at different levels of the healthcare organization, they contain different types of medical knowledge and are often standalone applications poorly integrated into the clinician’s workflow. Second, clinical decision support systems are not integrated into EHRs. Lack of effort, interest and skills needed to search for knowledge among the massive volumes of research being produced are other reasons. The research results also confirm that medical knowledge which has been captured and shared has not always been used, as it has suffered from shortcomings in its form. For example, the knowledge is usually presented in long documents, which makes it difficult for practitioners to absorb the information. To simplify access and ensure the application of knowledge that guides practitioners in practicing EBM, practitioners express an urgent need to integrate medical guidelines and relevant knowledge sources with EHRs.

Tacit knowledge sharing amongst healthcare practitioners, such as the sharing of clinical experiences, skills, or know-how, is known to have a significant impact on the quality of decisions (Panahi, Watson & Partridge, 2012). The importance of tacit knowledge in healthcare is well recognized and documented, yet the research results confirm that tacit knowledge sharing is difficult to achieve. The organization has failed to establish a tacit knowledge-sharing culture and to build a working environment that encourages the sharing of knowledge. In addition, practitioners lacked access to adequate IT-support for sharing their expertise and personal experiences. The healthcare practitioners emphasized the need for IT that supports the sharing of tacit knowledge between practitioners within and outside the organization.

The third research question to address is: How can future healthcare information systems support the availability of up-to-date patient information and relevant medical knowledge in a way which is seamlessly integrated with healthcare practitioners’ work practice? To support the availability of up-to-date patient information and relevant medical knowledge, future healthcare information systems must adopt a process-oriented approach, from the perspective of the patient process. They must also be more structured and standardized. Moreover, to improve healthcare quality and safety, future healthcare information systems should not only present current patient information, but also offer relevant information according to the current context. For example, a physician at an orthopedic unit should be given access to patient information that is relevant to that specific care episode.

Subsequently, since EBM heavily depends on both patient information and medical knowledge, future information systems must view patient information and medical knowledge as interconnected, such that they continually impact on each other. The inter-
connection is crucial, as the availability of patient information is a precondition for medical decisions and medical knowledge guides these decisions. Therefore, future information systems should support this view (see paper 6).

The fourth research question to address is: How can healthcare information systems support patient engagement through improved provider-patient communication? The short answer to this research question is that a process-oriented information system that follows the patient process can improve patient engagement. For example, a process support system, as the one described in paper 5, enables patients to access information about their own healthcare, which helps patients understand their health status and how it affects them. Patient engagement can also be improved by enabling patients to electronically fill in information regarding their own health, such as values, preferences and expectations, before a patient/doctor visit. Identifying patients’ values and preferences is important, as these must guide all clinical decisions. By developing information systems in a way which is inclusive, will enable patients to take control of their healthcare and therefore also empower them.

The fifth research question to address is: What recommendations can be initiated for the development of future information systems that (1) support healthcare practitioners’ access to up-to-date patient information and relevant medical knowledge in a way which can be seamlessly integrated with their work practice and (2) improve patient engagement? Based on the knowledge that was acquired by answering research questions 1, 2, 3 and 4, it is possible to answer the fifth research question. The primary recommendation is that healthcare information systems must support EBM. This means that healthcare information systems must support the availability of up-to-date and relevant patient information and medical knowledge (both access to and sharing of explicit and tacit knowledge) along the patient process, facilitate for patients to electronically access information regarding their healthcare and enable them to share their personal expectations, values and preferences. This recommendation requires that healthcare information systems are more process oriented from the patient process perspective, as well as structured, standardized and, above all, more patient centered. A process support system with an integrated IT-based knowledge repository, as proposed in papers 2, 5 and 6, is one step towards that direction.

6.2 CONTRIBUTIONS

The research presented in this thesis brings together knowledge from process orientation, knowledge management and evidence based medicine. Through the use of qualitative research methods, this work broadens our understanding of how information systems can be used to improve the quality and safety of care, by supporting the availability of patient information and medical knowledge in a way which is seamlessly integrated with healthcare practitioners work practice, and by supporting increased patient engagement. Hence, the main knowledge contribution of this thesis is within the field of information systems.

6.2.1 SUMMARY OF KNOWLEDGE CONTRIBUTIONS

The findings have resulted in the following contributions:

- Increased knowledge about how patients in Sweden experience the exchange of information with healthcare practitioners and how these experiences affect the quality of care.
This knowledge is a contribution to practice, as it offers new insights and new ideas on how to develop information systems that promote patient engagement. More specifically, this knowledge contribution is presented in paper 1 and answers research question one.

- **A “state of practice description” of how healthcare practitioners perceive availability of patient information, and identification of user requirements for future healthcare information system support.**

This knowledge is an important contribution to the field of practice, as it relates to how healthcare practitioners perceive current information system support, with regard to the availability of patient information, and how they want future information systems to support them in their daily clinical work practice. This knowledge contribution is presented in paper 2 and answers research question two.

- **A “state of practice description” of how practitioners perceive the availability of medical knowledge and how healthcare organizations work with the knowledge management process.**

This knowledge contributes to the field of practice, by highlighting (1) how healthcare practitioners perceive the availability of medical knowledge, when preparing and conducting patient visits, as well as when making decisions about patient care, and (2) the challenges healthcare organizations are facing when managing their medical knowledge. Therefore, this knowledge contribution answers research question two and is presented in paper 4.

- **A visualization demonstrating how patient engagement can be improved and how healthcare practitioners can be given access to up-to-date and relevant patient information and medical knowledge in an integrated manner and at the point of care, through the use of process-oriented information systems.**

This knowledge contributes to the field of research and to the field of practice, by showing that a visualized prototype developed in close collaboration with end-users is a suitable tool for illustrating both the opportunities and constraints with regard to the ideas and solutions of future healthcare information systems. The development of the prototype also contributes to the field of research, as it demonstrates solutions for how a process support system can facilitate the practice of evidence based medicine and improve patient engagement. This knowledge contribution supports research questions three and four and is presented in papers 5, 2 and 6.

- **A model that describes the relationship between EBM, knowledge management and process orientation.**

In addition to these primary contributions, the work has resulted in a conceptual model that describes the relationship between EBM, KM and process orientation. Up until now, no work has, to the best of our knowledge, linked EBM and its associated elements to process orientation and knowledge management. This model was developed on the basis of the literature review. Therefore, we believe that this integration is a contribution to research.
• A set of recommendations for the development of future healthcare information systems.

In order to address research question five, this thesis has provided a set of recommendations by which healthcare information systems can be refocused to improve patient engagement, as well as the timeliness of patient information and relevant medical knowledge along the patient process. The recommendations describe ideas for solutions that must be considered before work can begin with the development of future information systems. These recommendations can help avoid some of the more common pitfalls previously observed in healthcare information system projects. This contribution relates to research question five.

6.3 FUTURE WORK

Before a process-oriented information system, such as the one described in this thesis, can be implemented in practice, a number of challenges must be managed. For example, further research is needed regarding the ownership and responsibility of a process support system that crosses organizational boundaries and that supports patient-centered healthcare. Research regarding how the quality of the process data generated in a process support system can be assured and who bears the main responsibility for ownership of the process data are questions that future research must respond to. Subsequently, if a process support, such as the one described in this thesis, handles medical knowledge, additional challenges will arise. A crucial challenge, among others, will be to agree on the level that the IT-based knowledge repository integrated into the process support system should be at, the kind of knowledge that should be available in the repository, how this knowledge should be presented, and who will be accountable for the quality of the medical knowledge. A suggestion for future work is therefore to elaborate on what such an IT-based knowledge repository that is integrated into the suggested process support system could look like and how it could function. Subsequently, this work has provided a comprehensive picture of how a process support system can improve patient engagement. Further research is needed regarding how future process-oriented information systems can be developed so they are more inclusive in the way they enable patients to take control of their healthcare and thereby also empower them. Therefore, the next step is to examine other ways, than those demonstrated in this thesis, to engage patients in their own healthcare. For example, future research should examine what type of information patients want to access and why, as well as how this information can be made available through a process support system. Further research is also needed regarding how patients’ medical records can be made available through a process support system and how patients can enter information into their medical records.
# 7.1 APPENDIX 1: INTERVIEW GUIDE – CASE STUDY ONE

<table>
<thead>
<tr>
<th>Frågor till vårdpersonalen</th>
<th>Questions for healthcare practitioners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frågor relaterade till &quot;handläggning av vårdbegäran&quot;</td>
<td>Questions regarding the “processing of the referral”</td>
</tr>
<tr>
<td>1. Vilka ingångar är möjliga för en vårdbegäran?</td>
<td>1. In what ways can a referral be requested?</td>
</tr>
<tr>
<td>3. Vilka kriterier existerar vid prioritering av vårdbegäran? Var kommer dessa kriterier ifrån?</td>
<td>3. What criteria exist for prioritizing the referral? Where do these criteria come from?</td>
</tr>
<tr>
<td>5. Hur prioriteras vårdbegäran?</td>
<td>5. How is the referral prioritized?</td>
</tr>
<tr>
<td>Frågor relaterade till &quot;planering av besök&quot;</td>
<td>Questions regarding the “planning of patient visits”</td>
</tr>
<tr>
<td>1. Vad betyder &quot;gå igenom patientinformation&quot;? Vad är syftet? Vilka system används? Vem gör det?</td>
<td>1. What does it mean to go through &quot;patient information&quot;? What is the purpose? What systems are used? Who does that?</td>
</tr>
<tr>
<td>2. Vad gör du när du planerar ett mottagningsbesök?</td>
<td>2. What do you do when you plan a patient visit?</td>
</tr>
<tr>
<td>Frågor relaterade till &quot;genomförande av besök&quot;</td>
<td>Questions regarding &quot;carrying out the patient visit&quot;</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>3. Hur vet du vilka prover som behöver tas till mottagningsbesöket? Vilka svar krävs innan besöket bokas och planeras?</td>
<td>3. How do you know which samples that must be taken for the patient visit? What responses are required before the visit is booked and planned?</td>
</tr>
<tr>
<td>4. Vad är “ELVIS” för typ av informationssystem? År systemet integrerat med andra informationssystem som till exempel “Melior”</td>
<td>5. What type of information system is “ELVIS”? Is the system integrated with other information systems such as “Melior”?</td>
</tr>
<tr>
<td>5. Vilken typ av information innehåller kallelsen som sänds till patienten inför ett besök?</td>
<td>6. What type of information is included in the notification that is sent to the patient prior to a visit?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frågor relaterade till &quot;genomförande av besök&quot;</th>
<th>Questions regarding &quot;carrying out the patient visit&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vem ansvarar för ankomstförarandet? Hur går man tillväga?</td>
<td>1. Who is responsible for the arrival process? How is this process carried out?</td>
</tr>
<tr>
<td>2. Hur sker provtagningen vid ankomstförarandet?</td>
<td>2. How is the sampling at the arrival carried out?</td>
</tr>
<tr>
<td>3. Vad händer när vårdteamet möter patienten?</td>
<td>3. What happens when the care team meets the patient?</td>
</tr>
<tr>
<td>4. Hur går patientmötet till? Vilken information behövs? Vilken tillgång på information har du vid detta tillfälle?</td>
<td>4. How is the patient meeting carried out? What information is needed? What kind of information do you have access to during the patient meeting?</td>
</tr>
<tr>
<td>6. Vilken information behöver du för att göra din bedömning? Har du tillgång till något beslutstödsystem? Finns det behov för beslutstödsystem? Vilka är dessa behov?</td>
<td>6. What information do you need in order to make your decision? Do you have access to any decision support system? Is there a need for decision support systems? What are these needs?</td>
</tr>
<tr>
<td>7. Hur sker dialogen med patienten idag?</td>
<td>7. How is the dialogue with the patient carried out today?</td>
</tr>
<tr>
<td>9. Hur används standardvårdplaner i det fortsatta planeringsarbetet?</td>
<td>9. How are standard care plans used in the continued planning?</td>
</tr>
</tbody>
</table>
10. Hur sker receptskrivningen? Vad finns det för fördelar respektive nackdelar med receptförskrivning?

10. How is the prescribing of medication carried out? What are the advantages and disadvantages?

Frågor relaterade till "planera fortsättning"

<table>
<thead>
<tr>
<th>Frågor</th>
<th>Questions regarding the “continued planning”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Vad innebär standardvårdplan? Vad innefattar en standardvårdplan?</td>
<td>2. What is a standard care plan? What type of information does a standard care plan include?</td>
</tr>
<tr>
<td>3. Hur sker uppföljning/återbesök?</td>
<td>3. How is the following up of a patient’s visit carried out?</td>
</tr>
<tr>
<td>4. Hur skrivs den slutliga dokumentationen? Vilken information anges i dokumentationen?</td>
<td>4. How is the final documentation written? What type of information is included in the documentation?</td>
</tr>
<tr>
<td>5. Hur hanteras svar till inremitte-rande instans? Finns det några integrationsproblem?</td>
<td>5. How are the answers from the referring unit handled? Are there any integration problems?</td>
</tr>
<tr>
<td>6. Vilka kontaktytor finns med andra vårdgivare?</td>
<td>6. What kind of collaborations do you have with other healthcare providers? Which communication channels do you use?</td>
</tr>
<tr>
<td>7. Hur involveras patienten i planeringen av den fortsatta vården?</td>
<td>7. How is the patient involved in the planning of the continued care?</td>
</tr>
<tr>
<td>8. Hur skulle du vilja att patienten involveras i den fortsatta planeringen av vården i framtiden?</td>
<td>8. How would you like to involve the patient in the continued planning of care in the future?</td>
</tr>
</tbody>
</table>

7.2 APPENDIX 2: INTERVIEW GUIDE – CASE STUDY TWO (STUDY ONE)

Frågor till ansvariga för kunskapsportalen

<table>
<thead>
<tr>
<th>Frågor till ansvariga för kunskapsportalen</th>
<th>Questions for managers responsible for the IT-based knowledge repository</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vilka är kunskapsportalen’s målgrupper? Varför har denna målgrupp prioriterats?</td>
<td>1. Which are the user groups of the IT-based knowledge repository? Why has these user groups been prioritized?</td>
</tr>
</tbody>
</table>
2. Vilken struktur och teknisk lösning har valts för kunskapsportalen. Varför har dessa val genomförts?

2. What type of structure and technical solution has been selected for the IT-based knowledge repository? Why have these choices been selected?

3. Vad har du för organisatorisk modell för kontinuerlig förvaltning, inkl. ansvarsförhållanden för kunskapsportalen?

3. What type of organizational model do you use for continuous management of the IT-based knowledge repository?

4. Hur utvärderas kunskapsportalen? Har kunskapsportalen fått genomslag i den aktuella målgruppen/erna?

4. How is the IT-based knowledge repository evaluated? Has the IT-based knowledge repository had an impact on the target group/s?

5. Vilka möjligheter och utmaningar ser du med kunskapsportalen?

5. What opportunities and challenges do you see with the IT-based knowledge repository?

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7.3 APPENDIX 3: INTERVIEW GUIDE – CASE STUDY TWO (STUDY TWO)

<table>
<thead>
<tr>
<th>Frågor till chefer med anssvar för kompetensförsörjning och kompetensutveckling</th>
<th>Questions for managers responsible for competence maintenance and skills development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inledande frågor</strong></td>
<td><strong>Opening questions</strong></td>
</tr>
</tbody>
</table>
| 1. Vad ser du för utmaningar i att hålla verksamheten ”högkompetent”?
| 1. What challenges do you see in keeping the organization "highly skilled"?
| 2. När anser du att verksamheten är högkompetent? Vilka kriterier arbetar du mot?
| 2. When do you think the organization is highly competent? What criteria are you working towards?
| 3. Hur tar du reda på om verksamheten har den kunskap som behövs?
<p>| 3. How do you work with finding out whether the organization has the necessary knowledge that is needed? |
| <strong>Frågor relaterade till identifiering av kunskapsbehov</strong> | <strong>Questions related to the identification of knowledge needs</strong> |
| <strong>Frågor relaterade till identifiering av kunskapskällor</strong> | <strong>Questions related to the identification of knowledge sources</strong> |</p>
<table>
<thead>
<tr>
<th>4.</th>
<th>Hur arbetar du med att fånga in ny kunskap som behövs i verksamheten. Varifrån hämtar du ny kunskap?</th>
<th>4.</th>
<th>How do you work with the capture of new knowledge that may be needed in the organization? Where do you capture new knowledge?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frågor relaterad till processer för att sprida och implementera ny kunskap</strong></td>
<td><strong>Questions related to the processes for dissemination and implementation of knowledge</strong></td>
<td><strong>Frågor till vårdpersona- len</strong></td>
<td><strong>Questions for the healthcare practitioners</strong></td>
</tr>
<tr>
<td>5.</td>
<td>Hur arbetar du med att sprida och implementera ny kunskap i verksamheten?</td>
<td>5.</td>
<td>How do you work with the dissemination and implementation of new knowledge in the organization?</td>
</tr>
<tr>
<td>7.</td>
<td>Om verksamheten erfar &quot;best practice&quot; vilket ansvar tar du för att sprida denna kunskap till övriga i verksamheten (både inom och utanför den egna verksamheten)?</td>
<td>7.</td>
<td>If new &quot;best practice&quot; occurs in your organization, what responsibility do you take in disseminating that knowledge to other people (both within and outside the organization)?</td>
</tr>
<tr>
<td><strong>Typ av kunskap – Behov</strong></td>
<td><strong>Type of knowledge – Needs</strong></td>
<td><strong>Typ av kunskap – Behov</strong></td>
<td><strong>Type of knowledge – Needs</strong></td>
</tr>
<tr>
<td>8.</td>
<td>Vilken typ av kunskap behöver oftast &quot;uppdateras&quot; i verksamheten?</td>
<td>8.</td>
<td>What knowledge in the organization does usually need &quot;updating&quot;?</td>
</tr>
<tr>
<td>9.</td>
<td>Vilken typ av kunskap är svårast att fånga och implementera?</td>
<td>9.</td>
<td>What kind of knowledge is most difficult to capture and implement?</td>
</tr>
<tr>
<td>10.</td>
<td>Vilka områden anser du att personalen behöver mer kunskap om? Varför är den kunskapen viktig?</td>
<td>10.</td>
<td>What areas of knowledge do you feel that the employees need to know more about? Why is this knowledge important?</td>
</tr>
<tr>
<td>11.</td>
<td>Hur skulle du vilja att den kunskapen görs tillgänglig och presenteras? Varför just på ett sådant vis?</td>
<td>11.</td>
<td>How would you like that knowledge to be made available and presented? Why in such a way?</td>
</tr>
<tr>
<td>12.</td>
<td>Vilken kunskap är viktigast att prioritera utifrån din arbetsroll och varför?</td>
<td>12.</td>
<td>What knowledge is most important to prioritize based on your professional role and why?</td>
</tr>
<tr>
<td>Frågor relaterade till identifie-</td>
<td>Questions related to the</td>
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<tr>
<td>ring av kunskap</td>
<td>identification of knowledge</td>
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<tr>
<td>1. Vad gör du om ett behov av att</td>
<td>1. What do you do when you feel the</td>
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<tr>
<td>inhämta ny kunskap uppstår?</td>
<td>need to acquire new knowledge?</td>
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<tr>
<td>2. Hur brukar du ta del av kunskap-</td>
<td>2. How do you take advantage of the</td>
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<td>er och erfarenheert som redan</td>
<td>knowledge and experiences that al-</td>
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<td>finns inom organisationen?</td>
<td>ready exists within the organiza-</td>
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<tr>
<td>3. Hur brukar du ta del av den sen-</td>
<td>3. How do you take advantage of the</td>
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<td>aste forskningen och de senaste</td>
<td>latest research and the latest find-</td>
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<tr>
<td>römen inom ditt arbete?</td>
<td>ings within your field?</td>
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<tr>
<td>Frågor relaterad till processer</td>
<td>Questions related to the processes</td>
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<tr>
<td>för att sprida och implementer</td>
<td>for dissemination and implementa-</td>
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<tr>
<td>av ny kunskap</td>
<td>tion of knowledge</td>
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<td>4. Hur arbetar man i verksamheten</td>
<td>4. How is new knowledge implement-</td>
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<td>med att implementera ny kun-</td>
<td>ed in the organization?</td>
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<tr>
<td>skap?</td>
<td>5. How do you view a scenario where</td>
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<td>5. Hur ser du på ett scenario där</td>
<td>computer-based aids play a major</td>
<td></td>
<td></td>
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<tr>
<td>datorbaserade hjälpmedlen spelar</td>
<td>role in acquiring and disseminating</td>
<td></td>
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<tr>
<td>roll för att inhämta och sprida</td>
<td>knowledge? What opportunities and</td>
<td></td>
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<tr>
<td>kunskap? Vilka möjligheter och</td>
<td>challenges do you see?</td>
<td></td>
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<td>utmaningar uppfattar du?</td>
<td>6. How would you like to have access</td>
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<td>6. I den bästa av världar, hur skulle</td>
<td>to knowledge through your comput-</td>
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<td>du vilja få tillgäng till kunskap via</td>
<td>er?</td>
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<td>din dator?</td>
<td>Frågor relaterade till identifie-</td>
<td></td>
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<tr>
<td>7. Vilken typ av kunskap saknar du</td>
<td>Questions related to the identifica-</td>
<td></td>
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</tr>
<tr>
<td>oftast? Varför är den kunskapen</td>
<td>tion of knowledge needs</td>
<td></td>
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<td>viktig anser du?</td>
<td>7. What kind of knowledge do you</td>
<td></td>
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<td>8. Hur skulle du vilja att den kun-</td>
<td>miss most often? Why is this</td>
<td></td>
<td></td>
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<tr>
<td>skapen görs tillgänglig och pre-</td>
<td>knowledge important for you?</td>
<td></td>
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<td>senteras? Varför just så? Kan det</td>
<td>8. How would you like that knowledge</td>
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<td>finnas andra alternativ?</td>
<td>to be made available and presented?</td>
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<td>Why so? Could there be other alter-</td>
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<td>natives?</td>
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