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TOWARDS EFFECTIVE AND EFFICIENT INFORMATION SYSTEM SUPPORT FOR HEALTHCARE PROCESSES – A HEALTHCARE PRACTITIONER PERSPECTIVE

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ABSTRACT

Healthcare processes require the cooperation of different healthcare providers and medical disciplines. In such an environment, the quality and safety of care rely heavily on the ability to exchange information from one software to another, and from one person to another. However, information systems that support a seamless flow of information along healthcare processes are not broadly used in healthcare environments. Usually, healthcare organizations have their own autonomously developed information systems that do not support the cooperation of different organizational units and medical disciplines. This has led to the fragmentation of the patients' information in proprietary heterogeneous systems across healthcare organizations. The aim of this paper is to: (1) explore how healthcare practitioners´ in Sweden experience information system support in their daily work activities, and (2) present and illustrate how key design principles of a process support system prototype can support healthcare practitioners in their work practice. An important conclusion from this research is that a process support as the one described in this paper creates new opportunities to organize and coordinate healthcare.

KEYWORDS

Healthcare Processes, Patient Process, Process Support Systems, Information Systems in Healthcare

1. INTRODUCTION

Delivering good quality care is a complex endeavor that is highly dependent on information and knowledge (Bose, 2003; Rezazadeh et al., 2014). Numerous studies have demonstrated positive effects when using information technology (IT) in healthcare (Lenz & Reichert, 2007). In particular IT, such as electronic health records (EHRs), decision support, electronic prescribing, electronic referral and other technologies that enable the exchange of information have been promoted as potential tools for improving the quality, safety and efficiency of the

healthcare system. Despite these potential benefits, IT has never been used to its full potential. Nowadays, the traditional single doctor-patient relationship is increasingly being replaced by one in which the patient is managed by a team of healthcare practitioner, each specializing in one aspect of care. For example, a frail older individual who sustains a hip fracture may require treatment from an orthopedic surgeon, hospital nurses, and a hospital physical therapist, home care nurses, home care physical therapists, a primary care physician and a nurse in the primary care setting (Coleman, 2003). In such an environment optimal process support becomes crucial. However, despite their widespread adoption in industry, IT systems that support a seamless flow of information along healthcare processes are not broadly used in healthcare environments. Usually, healthcare organizations have their own autonomously developed information systems (IS) that do not support the cooperation of different organizational units and medical disciplines. This has led to the fragmentation of the patients' information in proprietary heterogeneous systems across healthcare organizations. Consequently, vital information stored in these systems cannot be easily accessed to present a clear and complete picture of the patient. This is worrying as, a seamless and shared care requires a high level of interoperability and information sharing among practitioners and care providers that are involved in the healthcare of a patient. In the absence of this information, a complex set of patient flows emerges where patient's medical records necessary for care have to be transmitted between and across department boundaries, which often leads to a high administrative load of practitioners (Lenz & Reichert, 2007). Medical procedures can even become impossible to perform if information is missing, medical tests may be repeated or prior findings ignored, preparations may be omitted, or a preparatory procedure must be postponed (Lenz & Reichert, 2007; Reichert, 2011), and in emergency care lifesaving information may be unavailable.

The aim of this paper is to; (1) explore how healthcare practitioners´ experience information system support in their daily work activities, and (2) present and illustrate how key design principles of a process support prototype can support healthcare practitioners in their work practice. The key principles of the process support prototype have earlier been presented in the paper by Åhlfeldt, Persson, Krasniqi and Wåhlander (2013), where the patient perspective is taken into account. Therefore, this paper aims to report on the issues healthcare practitioners in Sweden experience with regard to current information system support and how a process support system (PSS) can resolve some of the issues identified.

The remainder of the paper is organized as follows. Section 1.1 describes the theoretical background. The research approach is presented in section 2. The study results are described in section 3, following a description and visualization of how a PSS can support healthcare practitioners. The findings are concluded in section 4.

1.1 Theoretical Background

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 units and 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 (Shtub & Karni, 2010).

Moreover, 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). 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. 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 at the point of care is therefore difficult (Krasniqi & Persson, 2012).
- 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 (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).

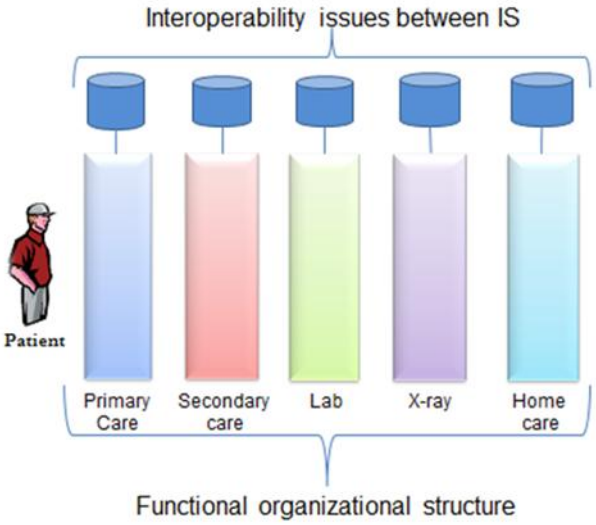

Figure 1. The structure of healthcare organizations

To improve efficiency and quality of care delivery, it is necessary to overcome the traditional functional organization structure (Gonçalves, Hagenbeek & Vissers, 2013). This can be done by the implementation of a process-oriented organizational view with supporting information systems. A process-oriented approach with supporting information systems is 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 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 (Vos et al., 2011), meaning that practitioners from different functions, such as orthopedics, surgery, physiotherapy, are 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). Moving toward process orientation can according to Willaert et al. (2007) provide numerous benefits, including cost savings through a more efficient execution of work and improved customer focus. Process orientation has also 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).

The starting point of a process-based organizational structure requires the identification of the core business process. The patient process is considered as one of the most important processes by many healthcare organizations (Åhlfeldt, 2008). 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. The patient process is according to Winge et al., (2007) defined as *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. One example of a patient process and the care providers involved in the context of this process is presented in figure 2.

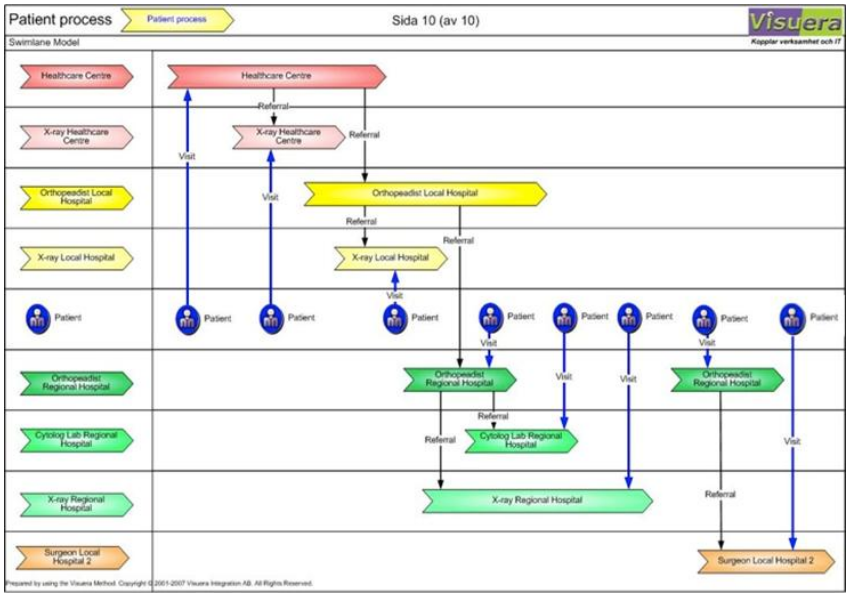

Figure 2. Example of a patient process and the care providers involved (Åhlfeldt, 2008).

Figure 2 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 between 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).

In recent years, researchers have tried to resolve the information system problems that exist by proposing various architectures for realizing systems and services that support healthcare processes. For example, Winge et al., (2014) proposed 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) focus 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 of this work. However, none of these have taken a holistic perspective where the patients' whole process and the communication between healthcare providers and the patient within this process are taken into account. Moreover, the process support system presented in this paper is based on a unique solution which is not found in existing research, where the process support drives the process forward, ensuring that the process is carried out properly and hence supports users in performing their work activities.

2. RESEARCH APPROACH

The prototype presented in this paper is a result of a research project named Future Healthcare Information Systems (FHIS). The aim of the project was to develop a visualization of a process support system that demonstrates the requirements for future process-oriented information system support. The vision for process support system is that healthcare practitioners, from all levels of healthcare, and patients should have access to effective collaborative information system that supports a process-oriented care where the patient is a distinct and active collaborator. The process support system was developed in close collaboration between researchers and healthcare practitioners from a local hospital in the Region of Västra Götaland, Sweden. Since, addressing all the healthcare processes with related information systems seemed like an impossible task for the project, it was necessary to select an appropriate delimitation. Therefore, the project chose a healthcare process that repeats throughout the healthcare system and that can demonstrate patient and healthcare communication; initiating, planning, carrying out and following up a patient's visit to healthcare providers. This process was termed *"Patient meeting"*. 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 information exchange with healthcare organizations and 3) identify user requirement for future process-oriented information system support. For this purpose, different data collection activities were conducted.

2.1 Data Collection Techniques

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, 2001). Eighteen semi structured interviews 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 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. 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. 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. The method used for modelling of the chosen process and for the prototype development was the Visuera method (Visuera, 2014). 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 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.

Modeling 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 (Visuera, 2014). 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.

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.

2.2 Qualitative Analysis

The analysis of the transcribed interviews and the observation field notes have been conducted with inspiration from the Grounded Theory research method. The aim of the analysis was to find central core categories which, according to Robson (2011) is 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. The initial step of open coding stared by reading through the interviews several times in order to create a deeper understanding of the respondents´ statements. Subsequently the actual coding stared. Open coding of the transcribed data has involved line-by-line coding of words and phrases by highlighting (Strauss & Corbin, 1990). Each word or phrase was assigned a concept noted in the margin. Example of a concept that has been identified is “support in decision making”. At this stage the coding was conducted directly in the word document by using the function “insert comment”. When no more concepts could be identified, they were grouped into border categories. Example of a category that relates to the above concept is “Lack of a holistic IS”. Axial coding involved further exploration of the categories and concepts that were developed in the process of open coding (Oktay, 2012; Strauss & Corbin, 1990). Axial coding was the process of identifying the relationship between and within categories. Axial coding did provide depth to the description of the identified concept, which evolved into a deep understanding of e.g., how practitioners experience access to information in the patient process and how patients experienced information exchange with practitioners. It also gave a deeper understanding of the difficulties practitioners experienced with regard to availability of information and how they want future information system to support work practice and thereby improve the quality of care delivery.

3. RESULTS

In the sections below, the challenges with information system support are described, following a description and a visualization of how a process support system can support the availability of patient information in a way which seamlessly integrates with healthcare practitioners work practice.

3.1 How Healthcare Practitioners Experience Information System Support

1. **Lack of a holistic system for information access**: Interoperability of healthcare information systems does not only hamper access to patient information, it also results 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 a complete picture of the patient. In the absence of this information, a complex set of patient flows emerged where practitioners had to spend valuable time on locating and collecting relevant patient information. Patient's medical record necessary for care was often transmitted between and across department boundaries, which resulted in a high administrative load of practitioners. Printed copies of the medical record were usually imported into the recipient's IS by adding a scanned version to the system or by typing a summary in the system. This entailed problems of inefficiency and the risk of making errors. Delays in treatment's were also common as practitioners had to wait for requested copies of the medical record, test results, medical list etc. Often patients even had to undergo similar test procedure because results of previous tests were unavailable at the point of care.
2. **Manual handling of information:** Much of the information managed in the healthcare processes was handled manually. For example, many of the information systems that were used during the patient meeting contained information that had been manually imported. The healthcare practitioner even told about situations where patient information had been missed to be imported into the IS or had been misinterpreted.
3. **Nonstandard, unstructured information:** In accordance with current research, unstructured information in the EHR has been identified as challenging. As the information in the EHR is recorded as free text, without limitations to the format or structure they were seen as time-consuming to review manually. 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. Therefore, there is a need to "rationalize" the data – resolve the terminology into standard set of terms (Inmon & Nesavich, 2007).
4. **Lack of care coordination between departments:** Care coordination is defined in the Agency for Healthcare Research and Quality (2010) as the deliberate organization of patient care activities between two or more participants involved in a patient's care to facilitate the appropriate delivery of healthcare services. Patients in greatest need of care coordination include those with multiple chronic medical conditions, concurrent care from several

healthcare practitioners, and patients undergoing extensive diagnostic workups or transitions from one setting of care to another (Agency for Healthcare Research and Quality, 2010). As patients often receive medical care from different providers enhanced care coordination becomes vital for the improvement of the quality of patient care. The healthcare practitioners emphasized that the coordination of patient care is a challenge due to interoperability issues. Another reason described is the functional organizational structure with task specialization. When each practitioner focuses on its function they usually fail to communicate critical elements of the care to the receiving department. Bottlenecks occurred as one department pushed the patient into another department that was not ready to take care of the patient. Lack of interoperable information systems and absence of electronic booking of treatments and examinations complicated the situation even more.

5. **Usability issues:** A common requirement among healthcare practitioners is that future information systems must meet the requirements for usability. Experiences such as, too much mouse clicking without feeling that they are getting closer to their goal were common complaints. In addition, interoperability problems resulted in double documentation, which in turn resulted in sub-optimal use of resources, and in worse cases it increased the risk for accessing different and contradictory patient information. The study result also confirms that current information systems do not support the users in the way they should be working. For example, while reading and/or writing in the EHR it is not technically possible for a physician to look at X-rays at the same time and in the same computer screen. Instead the physician must switch between different computer screens; between the X-ray and the EHR.

Moreover, the research study has shown that practitioners spend more time on trying to manage different information systems, to locate patient information, and to "figure out" how a specific IS works, instead of spending time with the patient. The study results confirm that 38 different system operations/ system transactions are made during a patient meeting, which means that the value creation time that needs to be applied on the patient is less than 20 % of a patient encounter.

6. **Complex information flows:** The healthcare sector is an information and a knowledge intensive organization comprising a large number of complex information flows. Healthcare practitioners found it difficult to orient themselves among these complex information flows. Interoperability issues complicated the situation even more.

7. **Incoming information from referrals is incomplete:** A recurring problem experienced among healthcare practitioners is related to the care request/referral. 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 required information where always sent back. The healthcare practitioners emphasized that this is one of the reasons why patients do not receive care within a reasonable time.

3.2 A Process Support System to Support Healthcare Practitioners

3.2.1 Overall Architecture of the Process Support System

The vision for the process support system is that healthcare practitioners and patients should have **access** to efficient **collaborative** IS that supports **a process-oriented care** where the **patient** is a distinct and active collaborator. The words in bold are concepts that the FHIS project paid particular attention to, meaning that:

- Appropriate parts of the process support system are available for both patients and practitioners taking 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 PSS.

The PSS can be viewed as a layer of abstraction or user interface above the various individual IS, enabling enactment of the process and interaction between patients and healthcare practitioners through computers and mobile devices without accessing each individual IS (Perjons et al., 2005). The process support system drives the process forward, ensuring that it is carried out properly and hence, supports users in performing their work tasks. The PSS also provides a user interface to the various systems involved in performing a work activity. The principle is described in Figure 3.

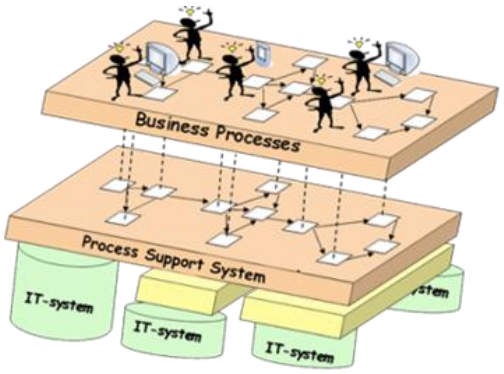

Figure 3. The principle of the process support system (Adapted from Perjons et al., 2005)

Moreover, the architecture 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-supported knowledge repository.

3.2.2 How the Process Support System can Support Healthcare Practitioners

The patient processes is in focus *(support challenge 1, 2 and partly challenge 6):*
A patient usually gets care from different healthcare practitioners. Each of these actors generates information that is needed by one another. Therefore, the PSS 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 record, lab-response, drug list) and administrative information (e.g. appointments) in a timely manner. The process support system follows the idea that all

information needed by practitioners when preparing for and carrying out a patient visit should be available, whether it is medical or administrative information. These types of information are currently separated in different information systems. The PSS 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. When the patient submits a referral, a healthcare practitioner will be notified (see figure 4).

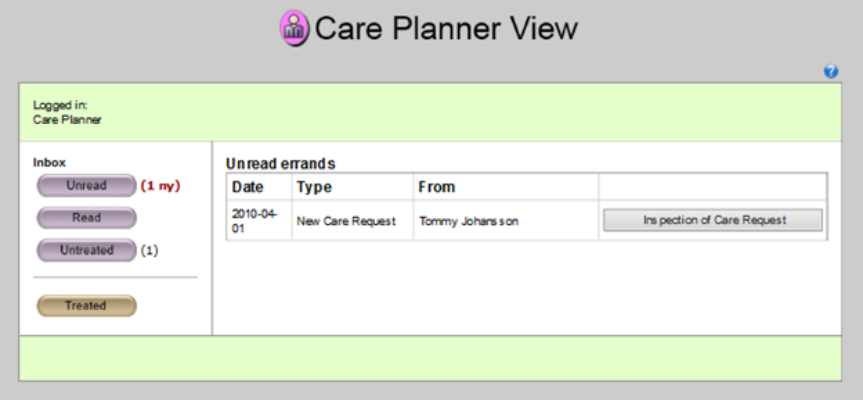

Figure 4. A patient has sent in a referral and a healthcare practitioner (a care planner who can be a nurse or a doctor) have received a notice in their process support system view (Åhlfeldt, Persson, Krasniqi & Wåhlander, 2013)

The process support system is based on standardized information *(supports challenge 3):*

Having the right information when it is needed is a challenge. 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. The process support system can also ensure that healthcare practitioners always have access to relevant medical guidelines. For example, when the physician plans for medical examinations the PSS provides support by showing what medical activities that should be prioritized and also conducted with regard to the diagnosis or health issue (see figure 5).

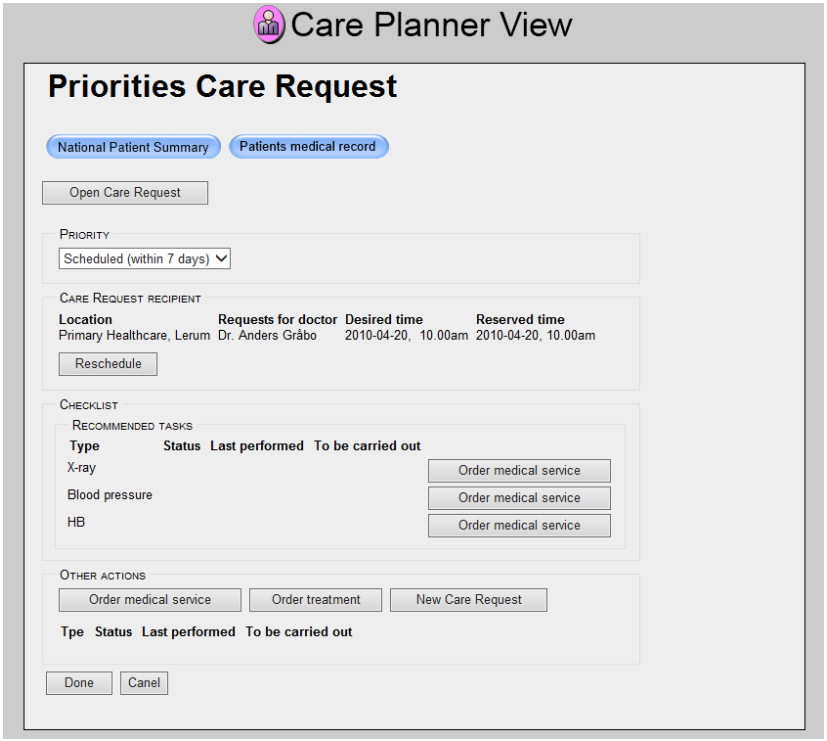

Figure 5. Checklist with recommendations regarding medical examinations.

Efficient information flows *(supports challenge 6):*

By adopting a process-oriented approach the information flows can be more efficient. The PSS can ensure that patients and practitioners always perform the correct activities during the different parts of the process. The challenge here, particularly in today's decentralized healthcare, is to determine which healthcare provider that should be responsible for performing which work activities and who should provide a specific type of information to the PSS. Moreover, by structuring for example the referral, it is possible to ensure that all important information that is recorded in the referral follows the patient process.

A major advantage of a process-oriented approach and tools that supports the patient process is that the PSS drives the process forward. For example, when a work activity is completed, the process support system will present nearby activities that must be performed. For example, when a practitioner in secondary care has written and signed the final documentation for the patient record, the PSS automatically picks up the form "response to care request" that must be sent back to the referring physician from primary care. The process approach also minimizes duplication of documentation, as already registered information follows the process and therefore does not need to be registered again.

Digital booking and coordination of patient treatments and examinations *(supports challenge 4):*

The process support enables electronic booking and coordination of the patients' 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.

Enhanced security *(is a prerequisite for all key design principles):*

In the current version of the PSS no specific technical security solutions are implemented. Instead, the process support system is based on the current national system for secure identification and access controls, included existing secure infrastructure platforms.

Increased coordination with secure infrastructure *(supports challenge 4):*

Another step in improving security and increasing the coordination between different healthcare organizations is the outlined integration with national solutions such as the National Patient Summary (NPS), which contains excerpts from patient records kept by different healthcare providers. The NPS can be accessed by both patients and healthcare practitioners.

Electronic care request *(support challenge 7):*

The care request within the PSS is based on standardized checklists designed from national quality registers. In order to prevent incomplete referrals, the care request within the process support system is based on mandatory information that must be completed before it can be forwarded. The information in the referral is thus based on standardized checklists from predefined national medical pathways/care plans. The information displayed in the referral is in turn governed by the selected patient health issue or diagnosis.

Improved usability *(supports challenge 5):*

The perceived usability problems have been considered in the development of PSS. The process support system is more efficient to use as it takes less time to accomplish a particular task. The mouse clicks are significantly minimized as the PSS enables the user to look at several different screens simultaneously at the same time.

4. CONCLUDING REMARKS AND FUTURE WORK

Delivering good quality care is a complex endeavor that is highly dependent on patient information. The study results have confirmed that practitioners lack access to information about the patient when preparing and conducting patient visits, as well as when making decisions about the care of the patient. An important conclusion from this research is that a process support system 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 also reduces double documentation and manual handling of information, which in turn reduces the risk of making errors. Since, healthcare practitioners no longer need to spend time in locating patient information or on managing non-user-friendly information systems, more time can be spent on meeting patients. However, much work remains before the suggested principles for the process support system can be fully implemented. One of the main challenges is that there

is no process owner of the patient process. A process owner is the person who has the authority to determine how a process operates, and have the responsibility to make sure it continues to meet patients and business needs today and into the future. Therefore, they play a vital role in sustaining process improvement, and are crucial for the organization. Other challenges are:

- To determine the ownership and responsibility of a process support system that crosses organizational boundaries and that supports a patient-centered care.
- Who should be responsible for the quality of the data that is generated by the process support system, and who should be the owner of this data.
- Which work activities within the process should the different levels of care be responsible for, which requirements can they impose on each other, for example if the patient seeks care in primary care because of hip pain and he/she is referred to the secondary care, who should do an x-ray? the primary care or the specialist care? These activities must be determined before the process support system can be implemented.
- What information should each level of care contribute within the process support system, and who should determine that?

Future research should study the above-mentioned challenges, as these are the major threats to a more process-oriented healthcare with supporting information systems. Further research is also needed regarding how future process-oriented information systems can be developed so they are more "patient inclusive" in a way that they enable patients to take control of their healthcare and thereby also empower them. More and more, physicians and patients are working together, increasing the exchange of information and sharing the decision-making. Therefore future research should examine what type of information patients want to access and why, how this information can be made available through a process support system, and how such a system can be developed so that patients themselves can provide information regarding their health, expectations, values and preferences. This information can complement the physician's knowledge of the patients' clinical situation. The effect of such solutions should also be studied.

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