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User-Driven Designs in Medical Informatics: Developing and Implementing Support for Inter-departmental Coordination of Hospital Work using Electronic Whiteboards

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Abstract. We present an ethnographic study of the organizational aspects of the use of an electronic whiteboard (EW) system implemented in a Danish hospital located in Nykøbing Falster (NFH). The EW system had originally been developed for the emergency department (ED), but had later been extended to the entire hospital, and the study was conducted about 10 months its implementation. The study focuses on coordination regarding *inter-departmental* ordering of surgical operations via the EW system. The research question asked whether clinicians experienced impacts, and challenges in this respect. The results of the study show that the EW system had been configured, and the use of it organized, in a manner that facilitates support of inter-departmental coordination of work. We identify, describe and discuss the challenges related to the difficulty of accommodating the heterogeneous practices and demonstrate the complexity of organizing cooperative work using artifacts and technology across organizational units.

1 Introduction

The use of electronic patient status boards or whiteboards (EW) is becoming increasingly commonplace in hospital facilities in the US and Europe. Numerous studies have been conducted with respect to how EW systems function in individual departments, in particular in emergency departments, and have studied the *challenges* and *impacts* of EW system implementation and use in an *intra-departmental* context. In this paper an impact will be understood as a marked effect or influence on someone or something, which may be positive, negative or neutral in nature. A challenge will be seen as a problem or impediment for someone or something, which may or may not be subject to change or be solvable. Few, if

any, studies have investigated the way in which EW systems have been implemented and used in an *inter-departmental* context (see below). In this paper, we investigate the research question:

> *What impacts and challenges do clinicians (say they) experience when using an electronic whiteboard system for inter-departmental communication (collaboration/coordination)?*

A hospital is an organization consisting of people belonging to various professions cooperating with each other with respect to the common goal of solving health care issues for other people. Hospitals are usually organized in a hierarchal pattern, where different departments deal with specialized functions. Mintzberg called this type of grouping "grouping by knowledge and skill." (Mintzberg, 1993, p. 49) The NFS is organized in accordance with this general pattern, and has 18 medical departments each of which have their own medical or technical/administrative specialty, examples being: the emergency department, the geriatric department, the anaesthesiology department, etc. (Region Sjælland, 2014). Some medical departments are further subdivided into subparts, for example the operating theatre is a subdivision of the anaesthesiology department. Each medical department has its own hierarchy with a chief physician and head nurse at the head of the department.

In dealing with how healthcare organizations operate it becomes relevant to consider the concepts represented by the adjectives *intra-* and *inter-departmental.* The distinction between the concepts of *intra-departmental* and *inter-departmental* is that while *intra-departmental* refers to something which has the quality or property of remaining within the boundaries of a *department*, *inter-departmental* refers to something that has the quality or property of reaching over the boundaries found between separate departments. Therefore in reference to communicating and coordinating work in a hospital setting, we distinguish thus between *intra-departmental communication and coordination of work,* which entails clinicians communicating and coordinating work within a single department, and *inter-departmental communication and coordination of work* which entails the contrary, which is clinicians belonging to separate departments communicating and coordinating work between separate departments in a distributed manner. A further dimension of the *inter-departmental* in this context is clinicians communicating and coordinating work between parts of the departmental hierarchy where tasks are coordinated or transferred between the domain of one department's chief physician and another's. This kind of transfer will inevitably entail a further layer of complication to health care tasks already characterized by complexity.

We have searched for articles dealing with the aspects of EW systems supporting *inter-departmental* communication and collaboration. The search process for finding related literature employed several search engines: Google Scholar, ISI Web of Knowledge, Springer Link, Elsevier Science Direct and ACM Digital Library. The key words used in the searches were a combination of "inter-departmental" and either "electronic whiteboard", "electronic patient whiteboard", status board" "interactive whiteboard" or "computerized whiteboard". What literature was found focused on EW systems in individual departments and not between departments with the exception of one article which dealt with how hospital IT-systems supported the manual process of transferring patients from one clinical department to another (Abraham & Reddy, 2010). However the whiteboard system involved here in supporting the manual transfer of patient was a bed board tracking system, whose sole function was to track

the availability of vacant beds in hospital wards, and was therefore functionally different from the electronic whiteboard system implemented at the NFS, which contained functionality that specifically targeted inter-departmental communication and coordination of work.

A literature review by Rasmussen (2012) clarifies the introduction of EW systems with respect to collaboration and coordination of clinical work. Rasmussen found that positive effects on coordination were caused by features of EW systems such as "distributed access to whiteboard information, quick and easy access to relevant information, the ability to retrieve previously accessed information" (ibid, p. 487). Negative effects were caused by "system deficiencies e.g. system properties that only allow three lines of text in comment fields, and the system's lack of support for other input than text, e.g. symbols…" (ibid, p. 487).

Other studies demonstrate how designers and clinicians strive to reach a balance between *tradition* and *transcendence* of work practices. Although tradition preserves the recognisability of work practices and work related artifacts' as much as possible to reassure users and ease learning and acceptance of new systems, it also has the disadvantage of freezing the situation and impeding innovation. On the other hand, transcendence of work practices happens when the new technology provides hitherto unimagined ways of performing tasks, and those opportunities are used to change existing practices (Rasmussen et al, 2010).

(Hertzum & Simonsen, 2014), present a before and after study conducted to assess the way the implementation of an EW system in the ED of a Danish hospital (called hospital A in the following) affected the distribution of clinicians' time between their tending to patients and spending time with other clinicians. The included assessment of the implementation clinicians' mental workload at time-outs and hand-overs. The study showed that after the implementation of electronic whiteboards clinicians spent less time in patients' rooms, but were in patients' rooms for longer periods of time when they were there. Physicians' mental workload in time-outs was greater after the implementation while nurses' mental workload at hand-overs was less. In the ED of another comparable hospital (called hospital B in the following) a similar study provided a different result, as clinicians here spent more time in patients' rooms *after* the implementation of the EW system than before (Hertzum & Simonsen, 2013). The differences in the studies were partially attributed by the researchers to the fact that clinicians in hospital B had had a better overview of patients using the dry-erase style whiteboards prior to implementation of the EW system that had clinicians in hospital A, so that clinicians in hospital B were better able to take advantage of the enhanced overview provided by the new EW system than was the case for clinicians in hospital A, who had experienced difficulties in creating an overview using the dry-erase style whiteboards.

2 Theoretical Background

2.1 Socio-technical Approach

Berg (1999) suggests using a *socio-technical approach* to developing and implementing IT systems, specifically with respect to *patient care information systems*, or PCIS. The term PCIS is used by Berg to denote something with a broader scope than just an electronic patient record, as it encompasses a range of information technology and systems used by healthcare professionals in the healthcare sector. The socio-technical approach to PCISs in healthcare is characterized by Berg with certain *starting points* having several *implications* for the development and assessment of such systems.

1. Healthcare practices are seen as heterogeneous networks. On the one hand, work practices, IT systems and organizational units should be seen as components of larger entities, while on the other hand should themselves be seen as assemblies or composite objects. The relevant term in the socio-technical approach is networks. Thus, work practices are "*networks of people, tools, documents, IT systems, procedures"*. Departments are *assemblies* that are composed of people and supporting objects functioning as a healthcare delivery entity. The point of this is to see IT systems not as just some kind of technology in the organization, but as a practice in itself composed of many parts, which cannot be taken apart in its social and technical parts and treated in isolation.

2. The nature of healthcare work. Healthcare work practices are collective, collaborative practices that focus on the "*management of patients' trajectories*". There is certainly a degree of unpredictability when clinicians face medical events in connection with patient care that require rapid reaction including some modification of the usual routines, the work having, therefore, a "*pragmatic, fluid character*". Multiple clinicians perform work, which requires negotiation to arrive at collective decisions relevant to the ongoing healthcare process. The first point is that there should be a focus on cooperative work processes rather than delineated, individual tasks. The second point is that it is difficult to capture the "essence" of work practices in pre-defined task descriptions or formal models.

3. An empirical orientation, with emphasis on qualitative methods. It follows from the preceding two points that the socio-technical approach emphasizes the necessity of securing first-hand empirical knowledge of any work practice related to the use of IT systems. The approach favours generating models over healthcare practices in a bottom-up process using empirical cases. The preferred mode of data collection is ethnographical/ participant observation supplemented with interviews and surveys. Although quantitative measurements may be useful, qualitative methods provide a better way of studying and understanding "*tasks, roles and responsibilities*" and the changes caused by the implementation of a PCIS.

2.2 EW System as a Coordination Mechanism

EW systems support collaboration and coordination of work between clinicians', i.e. it functions as a coordination mechanism (Schmidt & Simone, 1996). The coordination of work in our case focuses on clinicians in different departments engaged in agreeing upon the terms and conditions of transferring patients between the departments. Coordination mechanisms can be conceptualized as comprising a *protocol* stipulating work practices, procedures or workflows as agreed upon by the users of the IT system and the *artifact* comprising the IT system (Pors & Simonsen, 2003).

The *protocol* is the "*integrated set of procedures and conventions stipulating the articulation of interdependent distributed activities*" while the *artifact* is the material component that makes it possible to carry out the cooperative work prescribed by the protocol. The *artifact* in this instance is the EW system that supports the functioning of the protocol and the subsequent performance of the task of managing patient trajectories. The purpose of coordination mechanisms is to support a reduction of complexity where multiple actors must coordinate work in a geographically distributed context (Schmidt & Simone, 1996), or, as Berg phrases it, affording "*… an increase in the complexity of the work practice without a simultaneous increase in the complexity of individual interactions (Berg 1999, p. 391)*". Suchman suggests that in some cases a protocol may be *inscribed* in the artifact, i.e.

the protocol is supported and embedded in the technology ((Suchman, 1993) cited in (Bjørn, 2003)).

3 The Setting

Nykøbing Falster Hospital (NFH) is a medium sized hospital located in the Zealand Healthcare Region of Denmark. The hospital serves the catchment area of the islands of Lolland, Falster and the southern part of the island of Zealand. The hospital has 250 beds and handles annually a total of 35.000 hospitalized patients, of which 30.000 are emergency patients, in addition to 71.000 outpatients.

The EW system at the NFH is a distributed electronic system residing on a centrally located web server connected to a database server for data persistence. The user interface, which is constructed using web technology, is accessed by users via a hyperlink. The hyperlink activates an instance of the application in the user's web browser, requiring appropriate security credentials. As the application is located on a web server, the application is accessible from any computer device on the healthcare region's computer network to appropriate users. The system can be accessed from outside the healthcare region from PCs that are equipped with a special security device and digital key. Large display screens, the majority of which are touch sensitive, are attached to stationary computers that are located in halls and common work areas in hospitals. Access to the application on large screens in common work areas depends on user access privileges, as large display screens are generally restricted to use by staff attached to the department in which the large display screen is located.

Figure 1: Screenshot of whiteboard in action

The EW system has replaced older dry-erase whiteboards common in all hospital departments. The EW system displays patient information in a tabular, matrix-like form (mirroring dry-erase whiteboards) in which each patient is represented by an individual row of information, see Figure 1. For an elaborated description of the system and its functionality, see Rasmussen et al. (2010).

4 Research Design and Methods

A research design employing an ethnographic approach in conjunction with interviewing was chosen as the mode of collecting the qualitative empirical data. (Sometimes called organizational ethnography (Orlikowski, 1991, p. 8). The empirical work was performed by conducting observation sessions in three different hospital departments, after which seven

clinicians from these departments were interviewed in semi-structured interviews (Myers, 2013, pp. 119, 136). The empirical data were interpreted by means of affinity diagramming and diagnostic mapping techniques (Simonsen & Friberg, 2014).

4.1 Ethnographic Research Methods

Ethnographic research methods are a recognized approach to qualitative studies of HCI and IT systems, whether the object of the study is facilitating a design or evaluation process, or generating input to an iterative design and implementation process (Graham Button, 2009, p. 39). The use of qualitative research methods in the context of PCIS studies is similarly recommended by Berg. (Berg, 1999, p. 93) The target of the present study is the EW system at NFH, which is in a state of flux, as the process of re-design and organizational implementation still is ongoing. The healthcare region and the IT-vendor have employed an iterative and user-participatory design approach (Rasmussen et al., 2010), and this investigation is intended to discover the impacts and challenges clinicians say they have experienced in using the EW system. An ethnographic approach was, therefore, considered to be an appropriate choice for this study.

4.2 Collecting the Empirical Data

The empirical data was gathered via observation of participants and semi-structured interviews of several users who make real use of the EW system and some informal contact with users (Blomberg, 1993, p. 133) (Orlikowski, 1991, p. 8). .Hospital managers decided that the departments which were to be observered would be chosen in consultation with a clinician in the intensive care department who was experienced in the use of the EW system and that the technical introduction to the system would be presented by the EW system administrator. The clinican, who was the head nurse of the intensive care department, suggested that the observation sessions should be conducted in the operating theatre and the emergency department as these departments were very active users of the EW system. No clinicians would be selected for interviewing purposes until after the conclusion of the observation sessions

4.3 Conducting the Observation Sessions

The intial observation session was spent with the EW system administrator who explained to the observer in detail the functionality of the EW system while demonstrating the various functions. The next day an observation session of the intensive care department was conducted in the morning and in the afternoon the head nurse of the operating theatre was contacted and agreed to allow an observation session in the operating theatre. The work in the operating theatre (Actual surgery was off limits) was subsequently observed for two days, followed by an observation session in the emergency department. Handwritten, comtemporaneus notes were recorded during every session, which were daily transcribed to an electronic record to preserve all verbally transmitted information and non-verbal impressions.

4.4 Conducting the Interviews

Although many clinicians were spoken to and informally interviewed during the observation sessions, choosing specific interviewees was a process mediated by their immediate superiors in the organization.During the course of observing work in the three departments, the selection of interviewees was discussed with the head nurses of the departments being observed. The process of selection provided a total of seven interviewees: from the emergency department, 1 emergency doctor, 1 chief medical secretary and 1 emergency nurse; from the intensive care department, 2 nurses; and from the operating theatre 2 nurses. Of the seven interviewees only the emergency doctors was self-selected, all other interviewees were selected by their supervisors.

The interviews were conducted as semi-structured interviews. An interview guide was prepared containing 18 questions related to six themes: (1) the interviewee's role in the hospital, (2) coordination of tasks, (3) scheduling operations, (4) developing new functions or new patterns of work practice, (5) significance of work practice and (6) effects of the EW system's implementation. The themes were developed on the basis of the information previously gathered during the observation sessions. Each interview started by presenting the interviewee with the interview guide and explaining to the interviewee what the purpose of the study and the interview was. The interviewer followed the interview guide but allowed interviewees to range freely with comments and allowed them to introduce relevant topics of interest to them. All questions were eventually dealt with in the interview. All interviews were recorded electronically, and subsequently transcribed to text.

A summary of the duration and extent of the interviews and the observation sessions, which were conducted between the 26th of September 2014 and the 6th of November 2014, can be found in table 1.

	Number	*Average duration*	*Total duration*	*Transcripts*
Interviews	7	51.28 min.	359 min.	111 A4 pages
Observations	4	7 hours	28 hours	16 A4 pages

Table 1. Summary of interviews and observations

With respect to the accuracy of this study it may be said that the narrowness of the sample of clinicians involved and the short amount of time used is a weakness in the data collection approach. Therefore, the empirical data could potentially be less representative of the reality of the situation than it could have been had the sample been broader. Having said that we believe the picture presented by the data to be an accurate portrayal of the situation in these departments. Although we assume the objective reality of the EW system, the description of the way clinicians experience the use of the EW system is a result of interpreting the observational and interview transcripts, and as such contains an element of subjectivity.

4.5 Analysis of the Emprical Data

The qualitative empirical data was analyzed using the analytical methods described in *Collective Analysis of Qualitative Data* by Simonsen and Friberg (2014). The data were initially subjected to an *affinity analysis* whereby the observation and interview transcripts were manually coded, after which the codes were collected in groups or categories according to their degree of affinity. A total of 217 codes were produced at this time, grouped into 19 categories which each symbolized a theme or concepts. Each category was then provided

with a narrative attempting to describe its essence. The categories that became the topic of this paper were collected under the heading of *EW Support for scheduling Surgical Operations* and are called (1) Increased Flexibility in Coordination, (2) Decreased Flexibility in Coordination, (3) Actions compensating System Functionality and (4) Actions compensating Coordination Practices.

5 Results of the Data Analysis

5.1 EW Support for Scheduling Surgical Operations

The function supporting scheduling of operations was added to the EW system as a result of further iterations of the system development cycle, which took place after the EW system originally was launched. Modifying the EW system to support the process of scheduling surgical operations was an idea to expand the use of the EW for supporting coordination of work that was initiated by the operation theatre department and carried out by an implementation group consisting of participants from the operating theatre department, Healthcare Region Zealand and the IT-vendor.

The previous manual procedure was a procedure where the department that wished to schedule an operation, filled out an operation request form on a paper form, which was faxed to a designated multifunction printer located at the remote end of a corridor in the operation theatre department. Operation theatre nurses were assigned the task of continuously monitoring the multifunction printer to intercept incoming fax requests as soon as they appeared, and subsequently arranging the operation in accordance with the urgency of the patient's medical situation. This procedure typically required multiple phone calls between the operating theatre and the requesting department, and took a great deal of time and attention before an operation could be successfully scheduled. The procedure did entail flaws and patients were occasionally forgotten and days could pass before it was discovered that they were scheduled for an operation that had not been performed.

In the new EW-supported procedure, the department that wishes to schedule a surgical operation requests the operation in a new "Boarding Pass" column in the EW system. Activating the "Boarding Pass" column causes the patient's data to become visible to clinicians in the operating theatre department and enables them to become aware of the requested operation. No phone call or fax request are normally necessary for scheduling an operation, indeed hospital policy prescribes this procedure as the only permissible way to request the scheduling of an operation, with the exception of scheduling operations that need to be performed during off hours. The "Boarding Pass" column contains seven preparatory steps (part of a protocol) that must be completed before a patient can be transported to the operating theatre. The requesting department is responsible for executing these seven steps, the completion status of which is visible on the operating theatre department's EW system allowing clinicians in the operating theatre to keep abreast of how far each patient is coming along with respect to be ready for his or her operation. When the last step of the "Boarding Pass" has been marked as completed, the patient is ready for operation and may be transported to the operating theatre department as soon as possible. The patient is transferred when the operating theatre indicates in the EW system that it is ready to start operating, thus avoiding patients being unnecessarily transported to the operating theatre – or being forgotten.

Whilst the new procedure should have eliminated the need for telephoning and faxing requests to the operating floor to schedule surgical operations, the reality of the situation is

that clinicians occasionally do need to communicate by telephone because the new procedure does not function with 100 % reliability. Clinicians on both sides of a request for scheduling an operation may have reasons to suspect that a request visible in the EW interface is not accurately represented. For example, clinicians suspicious that a patient shown in the EW system as not ready to be operated on, is actually ready to be operated on, or that an operation shown in the EW system as being in progress, is actually completed, contact their counterparts on the opposite side of the request to verify patients' status. This means that verbal negotiation and telephone contact are still required to facilitate the coordination of operations, although only as a way of double-checking the information displayed by the EW system.

5.2 Increased Flexibility in Coordination

Coordination between departments with respect to scheduling surgical operations has become easier and more flexible for clinicians than before support for this process was implemented in the EW system. The new procedure for scheduling operations has largely eliminated the previous need for manually negotiating the scheduling of an operation, enabling time-savings for both the requesting department as well the operating theatre department itself. The new procedure has the extra advantage of eliminating the need for nurses in the operating theatre department to continuously watch the department fax machine to capture incoming fax requests as these now appear directly on the interface of the EW system. The EW system in the requesting department displays information that identifies which patients are in the operation queue, even though these patients may still be present in their own department.

5.3 Decreased Flexibility in Coordination

Departments use the "Boarding Pass" column's seven-step plan when preparing patients for a medical operation. Patients are, however, often ready to be operated on without anyone being able to know this because anaesthesiologists usually delay checking off the "pre-medication for anaesthesia" point in the seven-step plan in the "Boarding Pass" column. The reason for this delay is that anaesthesiologists usually pre-medicate patients in their home departments prior to patients being transferred to the operation theatre department. When anaesthesiologists treat patients in the patients' home department they will not normally have access to the EW system which makes it difficult to update patient status in the EW system on a real-time basis. Anaesthesiologists therefore wait with updating the patients' status with respect to premedication, until they return to the anaesthesia department, which means that it often takes hours before the true state of a patient appears in the EW system. A clinician stated:

> "*…if the anesthesiologist goes out to administer pre-medication for anaesthesia for 2 or 3 [patients], and there actually is a patient who is already ready, but does not appear on IMATIS, this happens because the anesthesiologist will first finish all of his patient before coming back [to his office] to mark the items off the checklist."*

In the meantime, patients who are ready to be sent to the operating theatre, remain waiting in their departments because their status in the operation theatre's EW system does not reflect their real status.

The EW system also lacks an option to indicate when anaesthesia is unnecessary, which means that anaesthesiologists are forced to check off the pre-medication for anaesthesia

checkpoint as if the patient has been pre-medicated even though this is not the case. The reason for checking a false positive is that unless this option is checked off, the patient will never appear in the EW system as ready to be sent to the operation theatre. In cases where patients do not require anaesthesia, clinicians must therefore remember to make a telephone call to the operation theatre to warn clinicians there of the anomalous situation. This telephone call is occasionally forgotten which risks endangering patients' health and safety. There have been occasions where patients have been sent to the operating theatre, without having been pre-medicated for anaesthesia because it had been decided that anaesthesia was not required. But when such patients begin to suffer pain, and demand anaesthesia, anaesthesia cannot be applied as pre-medication is absent. A clinician told of the following:

> *"It turns out that she [the patient] is not pre-medicated for anesthesia, she is not ready for anaesthesia and may not given anything. Not even painkillers, if the patient is not seen by the anaesthesiologist. But the department has checked all items, because they know that I collect no patients unless there are 7 out of 7 [items]! I cannot pick up the patient if there are only 5 of 7 [items]. The 2 of them consisting of pre-medication. So I had promised the patient something that I could not do because anaesthesiologist would not give her anything, when they came!"*

In such cases the surgical operation must be either cancelled or emergency procedures initiated if the surgery is already in progress. The situation becomes highly dangerous for the patient if clinicians forget to contact the operating theatre to warn them of missing pre-medication.

5.4 Actions compensating System Functionality

The "Boarding Pass" function has not eliminated a need for telephone calls and paper schemas, as some sub-processes involved in preparing a patient for surgery have been omitted from the "Boarding Pass" function.

All departments in the hospital are capable of scheduling a medical operation through the EW system and each individual operation will have its own particular degree of urgency and should be prioritized in accordance with its degree of urgency to protect patients' health and safety. The EW system lacks any way of visibly prioritizing operations to show the urgency with which operations must be handled. In order to create a proper prioritization of scheduled operations, nurses in the operating theatre department frequently call the home departments of the patients listed on the EW for an operation that day to get an idea of the urgency of the listed operations, unless the department requesting an operation already has given this information beforehand. A clinician said:

> *"It is not unimportant that you have talked to a doctor to ask: "How urgent is it that this patient comes in NOW?". We are an emergency hospital and many of our patients in bad shape. Some of them at least. So when a patient suffering multiple diagnoses appears [on the whiteboard], it should not wait too much and then I think it is a problem that we do not talk together [on the phone]. It is a problem when we do not talk together. So I have to call and ask the doctor: 'How important is it that he [patient] comes next. Or can it wait until we are finished with the scheduled program or whatever?*"

This part of the overall operation scheduling process remains therefore a manual procedure.

The operating theatre department aims to perform as many surgical operations during the day shift as possible, and avoids operating in the off hours unless a patient's health and safety would be jeopardized by postponing the operation. The operating theatre department's staff is minimized during the evening and night shifts, and staff is expected to sleep or rest in one of the staff rooms, while waiting for possible medical emergencies. In the circumstances, clinicians are not expected to continuously monitor the EW system for suddenly requested urgent operations. For this reason, the older practice of manually coordinating surgical operations with the operating theatre department is maintained during off hours.

5.5 Actions compensating Coordination Practices

Because senior clinicians, i.e. physicians do not update patient information in the EW system very much, nurses and secretaries need to spend time completing entries and reconstructing data in the EW system. This involves searching for relevant data in other medical systems, and requesting information from the physicians themselves.

At the end of a shift, surgeons may not have been able to perform every single operation that was scheduled to have taken place at that shift. Surgeons often forget to indicate on the EW system what operations weren't performed during the outgoing shift, and which need to be the first operations to be performed in the following shift. This means that surgical nurses on the next shift need to reconstruct the order of priority of operations by searching the records of other medical systems as well as in the EW system itself to resolve the proper sequence of operations in the upcoming shift.

Another example is where an operation that has been scheduled shows that the "Boarding Pass's" seven-step checkpoints have not been completed. Sometimes the patient's home department forgets to update the patient's data to its actual, current state, and the "Boarding Pass" seven-point checklist might actually have been completed. However, no one knows whether the patient is actually ready to be sent to the operating theatre. As an operating theatre clinician stated:

> *"Yes, there are seven items that must be checked off for the patient, and I have absolutely no idea how far they are with the process. I can only wonder when a long time elapses after the doctor calls and nothing happens. First I then wonder a little, and then I go and check which items are completed and if I wonder a lot, I will call up and ask what is up! Sometimes there's a good reason for it, and sometimes they just busy, which is a good reason.*"

Thus, clinicians in the operation theatre know this is a possibility and regularly contact a waiting patient's home department by telephone to check whether a patient is actually ready to be sent up, even though it does not seem to be the case from inspecting the EW system interface.

6 Discussion

Berg writes that it is unrealistic to expect a satisfactory result when implementing PCIS in organizations by merely "*installing and using a new technology*" (Berg, 1999, p. 94). This kind of approach to system implementation leads invariably to a system implementation inferior to what could be achieved using an iterative and user-participatory approach. In contrast, Healthcare Region Zealand chose an iterative and user-participatory approach to developing and implementing the EW system at NFH (Rasmussen et al., 2010, p. 10). A

generic EW system in the emergency department served as the point of departure for an iterative and user-participatory development process, in which the clinicians participated in the design and implementation process by "*continuously provide(ing) the implementation group with feedback leading to iterative revisions of the system, its configuration and the associated work practices*" (Rasmussen et al., 2010, p. 10).

The project implementing support in the EW system for scheduling operations used an experimental approach when extending the EW system with the "Boarding Pass" function. The EW system constitutes an *artifact* used to effectuate a process described by the *protocol;* the protocol being the instructions issued by the hospital which *prescribes* that all operations must be scheduled using the "Boarding Pass" function in the EW system, and *describes* how to go about it. The way in which the "Boarding Pass" function was created exemplifies several theoretical principles: the first principle it illustrates is the above way of perceiving the distinctness of the artifact and protocol, the protocol being the manifestation of the agreement between departments and the organization controlling the content of the work practice. A second principle is illustrated by the "Boarding Pass" function, which is actually a seven-step checklist. The checklist is a manifestation of a protocol, which is designed to regulate and manage the process of preparing patients for surgical operations. The protocol *is inscribed in the artifact* of the EW system as a digital checklist, which is programmed as part of the interface. A change of protocol with respect to the seven-step checklist would entail a technical reconfiguration of the digital checklist component. The third principle it illustrates is that real use by real users reveals the existence of conditions that enable designers to add *opportunity*-based change to a system (Orlikowski & Hofman, An Improvisational Model for Change Management: The Case of Groupware Technologies, 1997). This kind of change is enabled from real use, and based on feedback and suggestions from users' experience, designing something originally unplanned, such as a function that supports the scheduling of surgical operations. The fourth principle is the cyclic iterative user-participatory process. The function supporting scheduling of operations is a function that was added to the EW system as a result of further iterations of the system development cycle, which took place after the EW system originally was launched.

In connection with scheduling surgical operations the seven-step checklist lacks the option to indicate that pre-medication is unnecessary, presenting the dilemma of standardizing a complicated procedure and inscribing it in an artifact, in a way that functions smoothly in all circumstances. Berg describes the fluid and pragmatic character of health care work, and the pragmatic way in which clinicians compensate for the lack of sufficient information (Berg, 1999, p. 90): with respect to pre-medication the clinicians decide to communicate with other departments over the telephone to ensure patient safety since they are aware of the possibility of patients being designated as pre-medicated for anaesthesia, even though they might not be. Clinicians are aware that the coordinating mechanism is deficient, and make up for this deficiency in their own way. This is also an example of the challenge of being able to support the "interoperability" of the artifact (The "Boarding Pass" function's checklist) with the work practices of the operating department and the "home" departments scheduling operation in a way that is safe for their patients. The solution to the problem is indeed a technological solution (though new organizational issues may emerge once a technical solution is introduced), as the digital checklist requires modification to align it with the reality of operating theatre practices. In the meantime clinicians seek to ensure patients' safety by employing compensatory methods.

When anaesthesiologists and other physicians avoid contributing data to the system, they may do so because they find it pointless , illustrating the point that whenever people encounter a requirement to contribute time and resources to a system from which they seem to expect little benefit, people may begin to limit their contributions. As Grudin writes: "*most groupware requires some people to do additional work to enter or process information required or produced by the application*" and people commonly react to this disparity by withholding their contributions, (Grudin, 1994, p. 96). An exemplification of this principle is the task of pre-medicating patients, which takes place in patients' own department and not in the anaesthesiology department. Anaesthesiologists travel from department to department and from patient to patient without updating patients' "Boarding Pass" information in the EW system in real-time along their way. While technical difficulties in using random workstations may be the reason for this, another reason may well be that anaesthesiologists refrain from making the effort of updating the EW system in real-time because they perceive obtaining no personal benefit in doing so and prefer, therefore, to perform all updates later when they return to their own computers. A technical solution employing extra equipment for updates, perhaps a small handheld computer devices, which anaesthesiologists could carry with them at all times, seems attractive, however, adds complexity to the already complex task of pre-medicating patients, as anaesthesiologists would have to learn how to use a new device and remember to take it with them, and use it, on their rounds. Alternatively, an organizational solution that entails delegating the task of updating the EW system to an assistant resembles the rewriting of a job description where the delegated task becomes the explicit work of another person (Grudin, 1994, p. 96). Whether this solution would be feasible depends on whether the hospital or healthcare region considers it financially responsible, and that the assistant (and the anaesthesiologists) comply with the solution.

7 Conclusion

This study has examined the use of an EW system at NFH by employing qualitative research and analysis methods and has provided some answers to the research question which was

> *What impacts, challenges and do clinicians (say they) experience when using an electronic whiteboard system for inter-departmental communication (collaboration/coordination)?*

The study reveals a number of impacts and challenges where some of the impacts are challenges in themselves while other impacts are merely impacts. While it may be possible to design solutions for these challenges, feasible and effective solutions are not necessarily easily forthcoming.

The study found that the current EW system is both designed to and capable of supporting cooperative work between clinicians in different departments. The impact of its distributive nature and its presence in all departments of the hospital is to support communication and coordination of inter-departmental work for a variety of purposes. A further effect or impact is the relative ease with which clinicians may access stored and shared information about patients in a distributive fashion.

A major new impact is that the EW system now supports (and the hospital mandates its use) the ordering or scheduling of operations. Scheduling operations has transformed into a more streamlined form of inter-departmental communication and coordination. However, the

way in which support for scheduling operations has been configured, still poses challenges for the clinicians. The digital seven-point checklist for managing the preparation of patients for surgery lacks an option for indicating that no anaesthesia is necessary, for which reason clinicians supplement the supported function with manual communication and coordination to avert patient safety threatening risks. A technical solution to this problem is imaginable, but may be difficult to implement organizationally. Another challenge is posed by the "traveling" anaesthesiologists, who omit updating patient status real-time, thus slowing the flow of patients through the operating theatre and adding new potential risks to patient safety. A possible solution to this challenge would be to equip anaesthesiologists with portable computer devices, although this solution could be a challenge to implement. Another organizational solution could be to create a new mandatory procedure for updating the EW system real-time, but this could also be difficult to implement with limited financial resources.

The EW system functions as a distributive system with the capacity to support inter-departmental communication and coordination and it has been configured to support several important functions that are now in practical use. The momentum of the EW system's implementation and use of these functions is considerable, and hospital management is extending use of the EW system by mandating using the EW system for several procedures. However, the above-enumerated challenges exercise an inhibiting influence on the motivation of clinicians to wholeheartedly adopt and support the system by contributing time and resources to the common good, thus harming the diffusion of system use. The EW system competes with many other hospital systems demanding the clinicians' time and attention. Although the introduction of this new technology is accompanied by a requirement for clinicians to contribute time and resources, it appears that not all high-level clinicians, physicians that is, have fully complied with this mandate. Clinicians in some departments claim that although the system is an excellent innovation, it is not used very much. These circumstances give rise to a potential scenario in which the EW system remains in solid use for those functions, which it already supports with success, but where its use atrophies in all other aspects, as disuse causes its momentum to stagnate.

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