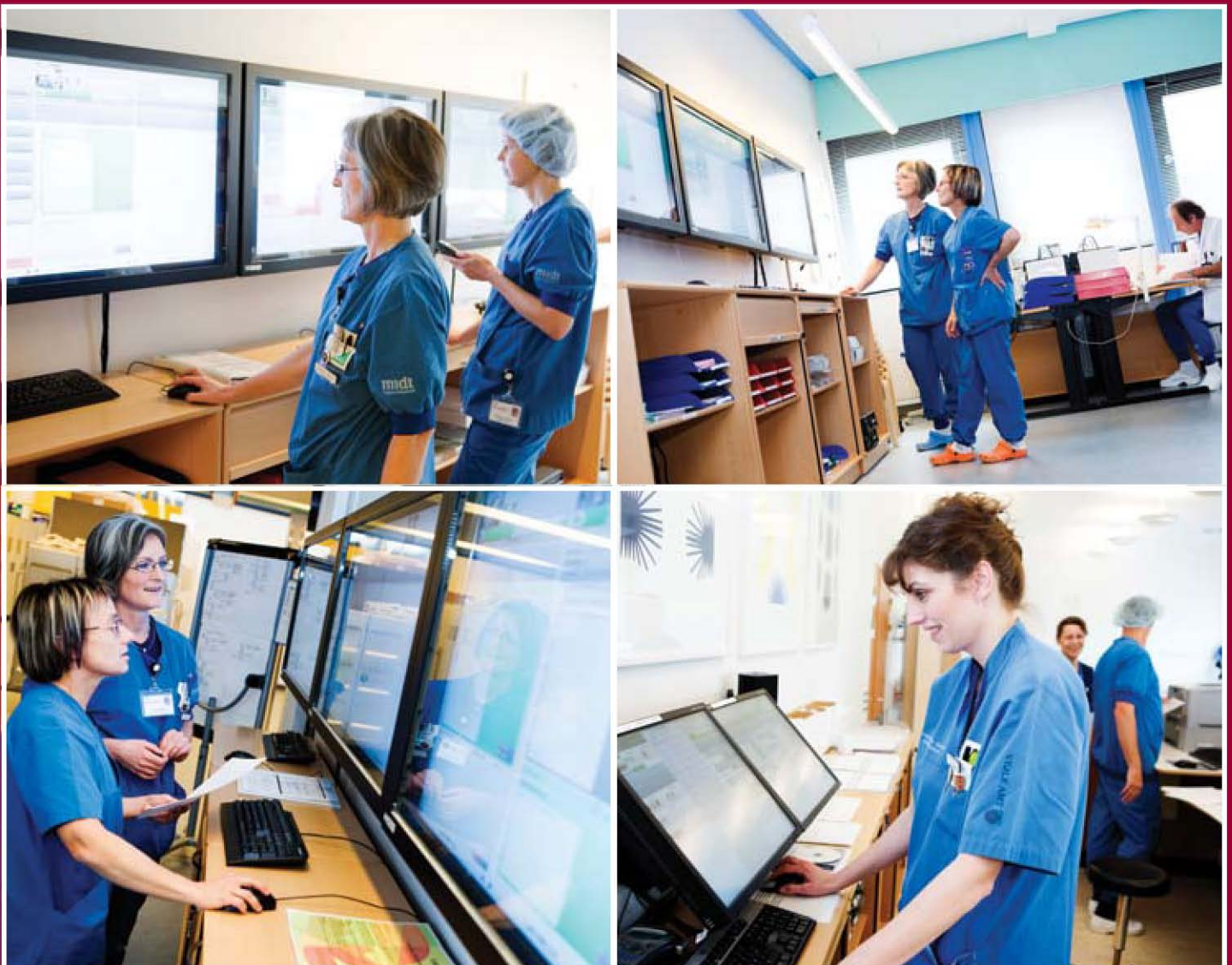# Health Technology Assessment of The Interactive Hospital (iHospital)

2009

HTA and Health Services Research
Centre for Public Health
Central Denmark Region

Health Technology Assessment of The Interactive Hospital (iHospital)

Preface

The Interactive Hospital (iHospital) is a new IT-system developed to support the working procedures of health professionals in correlation with the execution of a working day's surgical programme. The goal is to optimise the coordination of the complex cooperation existing around the execution of surgeries in a hospital. The system is developed within the research paradigm pervasive healthcare, and it is in many ways an expression of innovative thinking within design of IT systems that support the working procedures of health professionals.

The system is developed in close cooperation with health professionals at the Horsens Regional Hospital, Denmark, and is at present time implemented and running in several sections. As a result, the management of the Horsens Regional Hospital has expressed a wish to examine the effect of this implementation. The choice fell on health technology assessment (HTA) as method for examining possible effects of the implementation of iHospital.

The choice of HTA as a method for evaluating the iHospital is an expression of innovative thinking. The assessment of the effect of IT systems within the framework of an HTA is a challenge for the researchers, because it differs from HTA of for instance medicine or surgical procedures. The two central challenges of assessing IT systems are:

- IT systems are rarely static from the day they are implemented in the organisation.

- It can be difficult to survey the total effect of IT systems because the effect often exists in many different parts of the organisation.

To complete the HTA of iHospital has therefore been an exciting developmental task with regard to finding methods suited for assessing the effect of the implementation of IT systems in an organisation. The developmental task is obviously not fulfilled; it has just been started.

This HTA is primarily directed at decision-makers in order to support decisions regarding a potential introduction of iHospital or other competing systems.

HTA and Health Services Research
Centre for Public Health
April 2009

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Contents

Summary

This Health Technology Assessment (HTA) is made with the purpose of evaluating whether or not the implementation of the Interactive Hospital (iHospital) has led to an efficiency improvement in the organisation of the daily surgical programme and the surgical processes in general at Horsens Regional Hospital. Moreover, the HTA will clarify the use of and attitude towards iHospital among the staff.

iHospital is a new IT system developed within the field of pervasive healthcare/pervasive computing. The system consists of different constituent elements. The pivotal idea is to give health professionals a common awareness and an overview, primarily on large interactive screens, of the procedures of the day and the activities of their colleagues.

The report initially describes the central technology in the HTA (iHospital). Different data collection methods have been used in connection with this HTA. The collected data have been used across the sections of the report and an overall method section has thus been made. Organisational aspects of the implementation of iHospital are described followed by an economic analysis focusing on productivity. Furthermore, the patient perspective is briefly mentioned.

Overall method section

This HTA uses different data collection methods to illuminate the problems from several different angles as it is difficult to measure the effect of the implementation of IT systems in an organisation; moreover, the assumption is that possible effects would be found in different parts of the organisation. The data collection methods used were: observations, interviews, questionnaire, time registrations, register studies, qualitative review of unintended consequences and a literature review.

Different theoretical perspectives have been applied in the analysis of the collected data.

Technology

The purpose of this section is to introduce the reader to iHospital as a concept and as a system. The following elements are highlighted:

The organisation at modern hospitals is extremely complex. Conducting a highly specialised surgical procedure is a complex task involving surgeons, nurses, anaesthesiologists, the patient, an operating room and various types of equipment. Additionally, there is the coordination of cleaning, patient transport, recovery etc. Even though the day at a surgical ward is carefully planned, delayed surgical procedures, acute patients and other unexpected events cause the surgical programme to change rapidly.

On the basis of the complex organisation of a hospital and with specific focus on the surgical ward, iHospital was developed in close cooperation with researchers from Aarhus University, the industry and Horsens Regional Hospital. The technological solution behind iHospital consists of a number of different technologies all developed to support one or more of the challenges that healthcare professionals meet in their striving for an efficient and fast management of the daily surgical programme.

Some of the technological solutions are centered on large interactive screens centrally placed at the surgical ward and smaller screens placed in the operating rooms and at other locations at the

hospital. The screens of iHospital provide information on the day's surgical programme, staff, patients, operation equipment, surgical status etc.

The technology behind iHospital supports, among other things, that any change in the surgical programme can be viewed immediately on all screens throughout the hospital. At the same time, it is possible for staff to send messages to each other using a chat function.

Organisational perspective

The purpose of the organisational perspective is to assess whether the implementation of iHospital has changed the organisational model at the surgical ward when it comes to management of the daily surgical programme; moreover, to clarify whether iHospital supports the central mechanisms in the optimisation of the organisational model at Horsens Regional Hospital. Furthermore, the purpose is to assess whether the implementation of iHospital has been important for the working environment among the involved staff. The following should be mentioned on the basis of the conducted analyses:

Case descriptions of different patient pathways before and after the implementation of iHospital compared with a description of the overall workflow at the surgical ward renders it probable that changes has not occurred in the basic organisational model at the surgical ward. This is related to the management of the daily surgical programme.

For the system to have any effect on the organisation, it is a prerequisite that the system is used in the daily work. The questionnaire shows that staff uses the different functions of iHospital in their daily work to a great extent.

The analysis shows that the use of iHospital provides a better overview and an improved communication flow for the staff as well as supports coordination of the work. Theoretically, these elements are the most important mechanisms to optimise the organisation concerning management of the daily surgical programme.

The analyses show a positive attitude among the staff towards iHospital's influence on the working environment: a better overview, fewer interruptions in the daily work and a positive impact on staff communication, resulting in a more friendly tone. Moreover, several staff members mention that the use of iHospital causes less unrest during a working day.

Economy

The purpose of the economic analysis is to estimate a possible productivity gain by implementing iHospital at Horsens Regional Hospital. The following should be mentioned on the basis of the conducted analyses:

An analysis of the productivity was made at the hospital on the basis of DRG values. The hospital had a marked increase in productivity in 2007 and 2008, i.e. in the period where iHospital was successively implemented. The sub-analysis does not show whether iHospital or other factors were the direct cause of this.

The subsequent analyses of time registration also show that iHospital could have had a positive effect on productivity. Calculations e.g. show that the average part of the opening hours at the operating rooms used productively (i.e. where surgical procedures were performed) has increased at operating rooms using iHospital.

The results of the questionnaire and the conducted interviews also support that implementation of iHospital has resulted in a productivity gain. At the same time the results also indicate that other factors are important for productivity at the hospital.

Generally, both organisational and economic analyses show that their results cannot and should not be interpreted without considering the context in which data were collected. iHospital creates the prerequisites for increasing productivity and creating a better working environment due to the improved overview, communication flow and support of coordination. Use of these advantages also depends on the organisational set-up, management and many other factors. The use of theory in the conducted analyses supports and strengthens the external validity of the results.

Patient perspective

The purpose of analysing the patient perspective was the expectation that implementation of iHospital would reduce the number of unintended consequences, as the hospital staff would have a better source of information and an improved overview of the daily surgical programme. It was expected that this would cause the staff to be able to give better and more precise information to patients and relatives. The following should be emphasised:

iHospital is originally not developed as a technology focused directly on patients at hospitals. In this way iHospital is not a technology that patients can get in contact with or relate to, as they are not aware of the possible influence that iHospital might have on their course of treatment. Only by the use of secondary sources, information about iHospital's possible effects on patients can be obtained.

Through a qualitative review of unintended consequences, eight events which could potentially have been avoided if iHospital had been implemented at the time of the unintended event were identified. This is the best estimate of events that mayhave been avoided if iHospital had been implemented at the time of the events.

A large number of the employees who were in direct contact with patients and relatives and whose primary task is to inform them about the time schedule of the surgical procedure find that iHospital provides the opportunity for providing better and more precise information to both patients and relatives.

Perspectives

To our knowledge, this HTA is the first Danish HTA to assess a new IT system in the health care sector focusing on organisation of working procedures among health care professionals. It is thus in itself an "experiment" in investigating how far the concept of the HTA would be useful when dealing with this type of problems. The report shows that it is possible to obtain useful results by using the HTA as the framework for analysing the implementation of IT systems in the health care sector.

The two central challenges in conducting an HTA of an IT system implemented in the health care sector are the interdependency between results and context and the fact that implemented IT systems in general are continuously being developed. Considering the fact that many IT systems are implemented in the health care sector these years, it would be useful to start developing methods that would refine and expand the possibilities for assessing the implementation of IT systems within a total HTA perspective.

An HTA like this can contribute to creating a certain transparency and shed light on the consequences of implementing a system like iHospital in a specific organisation. In this way, this report can contribute to forming a basis for decisionmaking when discussing the possible implementation of iHospital at other Danish hospitals.

Glossary

Budgetary management framework: A financing system in which hospitals are assigned an annual budget.

Case study: A strategy for empirical exploration of a selected present phenomenon in its natural relation by applying various data sources that can be used in a presentation of evidence.

Context-aware computing: Within computer science context-aware computing refers to the idea that computers can both sense and respond to the background of the environment it is located in.

DRG: Abbreviation for 'diagnosis-related grouping'.

Dummy variable: A variable in a regression analysis that can take the value 0 or 1. It is used, for instance, to clarify the meaning of categorical variables (such as yes/no questions).

Actual operative period: The part of the operating room's opening hours in which surgeries are performed. That is, subtracted the preparation of the rooms, cleaning, anaesthesia time and general waiting time for patients, equipment and staff.

Comparative analysis: An analysis where different cases are compared.

Monetary value: The value of resource consumption converted to Danish kroner.

Lean: The basic idea behind Lean is to ensure that all activities add value to the organisation with a minimum of organisational waste and with the most optimal flow in the working procedures.

Odds ratio: The relation between odds (the likelihood of a certain outcome) in two groups.

Pervasive/ubiquitous computing: Computer technology which provides the opportunity of interaction in multiple places and not only at one workplace. This includes hand-held or mobile units, big interactive monitors, wireless infrastructure for networks and voice and vision operated technology. The concept covers a technology that ideally exists or is present everywhere at the same time, at a constant level.

Pervasive healthcare: Pervasive healthcare covers the usage of pervasive computing (see above) within the health care sector, and a vision to make healthcare available everywhere at every time and for everyone.

Productivity: The relation between output and input, for instance expressed by the number of operations (output) divided by wage costs (input).

Proof of concept: Proof which demonstrates that a model or a new approach is operative, a possible solution that is capable of solving or reducing a certain problem.

Reliability: Dependability. The method must measure the same every time.

Significance: Refers to a statistic calculation of the probability of having observed the data in question if there was not any effect. An empirical result is often called significant if its probability is smaller than 5 % (95 % significance level).

Turnaround between surgeries: The time that passes from when one operation is complete till the next operation starts.

Rate management model: Financing system in which hospitals are paid on the basis of rates and number of produced services.

Validity: Accuracy, quality.

Workflow: The means of which a process and/or procedure an assignment is solved by. A workflow specifies which tasks are necessary to solve and in which sequence (both linear and parallel).

1 Introduction

1.1 Background

The tasks of a hospital are of a very complex nature. The complexity of treating a patient is matched by an evenly specialised and complex organisation. Few tasks in a hospital can be performed by a single person on a single location. The hospital staff is often spread over a large geographical area which makes it difficult to sustain a common consciousness and an overview of processes and personnel that are involved in a course of treatment. This lack of consciousness leads to situations of which hospital employees spend much time on locating colleagues, and of which many unwanted interruptions occur during a working day. Information is normally not gathered in one place in a hospital but is scattered over several different locations. As a result, hospitals can be viewed upon as an information space, and it is by navigating in this space that hospital staff gets access to the information needed [1]. Hospitals use many different technologies in the attempt to provide necessary information and smooth coordination [2;3].

The conditions of a surgical ward are different from the rest of the hospital in terms of the need for coordination and information. To schedule and coordinate operations in a surgical ward is a challenging task in any modern hospital. To perform an operation is a highly specialised and advanced task which involves surgeons, nurses, anaesthesiologists, patients, operating rooms and various equipment. Additionally, cleaning, patient transportation, recovery etc. also have to be coordinated [4]. Although the working day in the surgical ward is carefully planned, delayed operations, acute patients and other unexpected events quickly make the surgical programme a subject to change. The coordination of these changes requires input and exchange of information from many different individuals andoccupational groups. This exchange of information proceeds as the surgical programme changes continuously because of various unexpected events. Every time a change in the surgical programme occurs, it affects the remaining programme for the day, and every personnel involved has to be informed of this change. To pass on status information and information concerning changes in the surgical programme to the relevant staff is furthermore complicated because of the nature of the tasks, in which the personnel is in constant movement, talking to patients and conducting surgeries. Consequently, in large hospitals much time can potentially be wasted on locating staff, patients and equipment.

The coordination task that the health professionals are facing is complicated further by the fact that there is a lack of well-performing systems that are able to support the kind of information handling and coordination that exists in a hospital. In most surgical wards, surgical programmes hanging on whiteboards and phone contact are the most widely used methods to inform the staff about status and changes in the surgical programme of the day [4]. Studies of the work in surgical wards have shown that large visible surfaces, such as whiteboards and other kinds of boards, are essential in the attempt to coordinate and inform about the day's surgical programme. The main reason for using whiteboards in hospitals is their visibility and accessibility. This visibility and accessibility presupposes, however, the staff to move to locations where the boards are placed [5;6].

Because of the mentioned circumstances in hospitals, it appears to be desirable for larger hospitals to consolidate planning, supervision and coordination of specific functions. These coordinator functions become very central, and even though this work will often function as the glue that holds the complex organisation together, paradoxically it is often invisible to external viewers and it rarely leads to clearly defined results [7].

1.2 The Interactive Hospital (iHospital)

The Interactive Hospital – abbreviated 'iHospital' – is the name of a research project conducted in a collaboration between Centre for Pervasive Healthcare at Aarhus University, Horsens Regional Hospital, Medical Insight A/S and Danish Data Display A/S, all situated in Denmark. The project spanned from mid-2003 until mid-2006. The purpose of the project was to conduct research in future IT technology for use in the clinical work in a hospital within the research area of 'Pervasive Healthcare' (see below).

Specifically, the project resulted in a series of concepts for new technology developed in close collaboration between the participants of the project. During 2005, Centre for Pervasive Healthcare developed four of these concepts into technological prototypes which were installed as a pilot project in the central surgical ward in Horsens Regional Hospital inDecember 2005.

The basic thought behind these technologies is to maintain the best functions of whiteboards while simultaneously improving these features by the means of computer technology, including mobile phones and the tracing of personnel. The system consists of several different constituent parts, but the central idea is to contribute to providing health professionals with a common consciousness and an overview of the execution of their daily work and what their colleagues are doing. The system is combined with a message function that supports asynchronous and less disturbing ways of communicating and submitting information. At Horsens Regional Hospital these systems are colloquially referred to as The Interactive Hospital, or iHospital – and the systems have thus taken their names after the original title of the research project.

In 2006 the research project ended and the technologies and systems were transferred to a newly started company, Cetrea A/S, which has subsequently developed a series of products based on the technologies and concepts.

iHospital is to a great extent the name of which the system is recognised at Horsens Regional Hospital and at other places. For that reason, the system will be referred to as iHospital in the remaining part of the report.

However, it should be emphasised that this HTA study is conducted in the period 2007-2008. It is thus conducted on the product version of iHospital and not on the original research prototype.

1.2.1 Pervasive computing

Technology has always played a central role within medical diagnostics, treatment, follow-up, monitoring and prevention. These technologies range from the simple stethoscope to advanced x-ray pictures, MRI scans and the like. Medical informatics is the discipline parallel to this process, covering the use of computers for medical purposes. Medical informatics often deals with informatics understood as the use of information technology for storage and administration of as well as access to medical data. Computers appeared in hospitals for the first time more than 40 years ago. They were predominantly used as support for administrative tasks. These information systems still constitute a significant part of many hospitals, but the focus of computers in hospitals are to a greater extent spreading from supporting administrative tasks to also supporting health care professionals in their work with patients. In the latter, computers are expected to help reducing medication errors, heighten the quality of the treatment and reducing costs [8;9].

Pervasive computing thus attempts to define a different approach to the use of computers than the traditional office computer, which is usually in focus within medical informatics. Allthough

pervasive computing is not a particularly well defined area per se, and because the technology is constantly under development, there is neither a precise, adequate definition of the concept of pervasive computing nor a precise separation from similar concepts such as ubiquitous computing or ambient intelligence. In an article about ambient intelligence, Mahesh et al. define ubiquity as the idea of something that exists or is present everywhere in the same time at a constant level. The authors seek to specify the concept further by stating that the widespread use of the concept of ubiquitous computing technology is equal to every computer technology that provides the possibility of interaction at more than just a single workstation. This includes handheld or mobile units, big interactive monitors, wireless infrastructure for networks and voice and vision-operated technology [10;11].

The area of pervasive computing is characterised by great research activity in which it is sought to combine engineering, computer science and research in man-machine interaction. The vision behind pervasive computing is to create computers that take into account the natural human environment and by doing so creates the possibility for the computer to step into the background. The objective is for the computer to become invisible at the conscious level so that humans will unconsciously use computers to solve their daily tasks. The idea is to create computers that adapt to the human environment in stead of making people adjust to the conditions of the computer [8;9;12-14].

1.2.2 Pervasive healthcare

The characteristics of the health sector are fundamentally different from more traditional office and domestic environments. The health professionals often have to use technology in hectic situations and in 'unfamiliar' or unusual environments such as operating rooms, intensive care units and on accident sites. Their work requires them to be extremely mobile and they often lack a desk and a personal computer for their own particular use. Their work requires collaboration and they rarely work on a personal task on a private computer. Mobility, collaboration, interruptions, ad hoc problem solving and physical tasks are fundamental aspects that characterise the work that nurses, surgeons, radiologists and their like perform. Because of the nature of the clinical work, the conventional desktop PCs are not particularly suitable for clinical tasks [1;8;9;13].

To use pervasive computing within the health sector is called pervasive healthcare. Hence, iHospital is developed within the research field of pervasive healthcare.

The definition of pervasive healthcare contains two elements:

1. The use of pervasive computing within the health sector

2. To make the health sector available everywhere at any time and to everyone.

The concept of pervasive healthcare has two equal dimensions:

3. An information technology dimension

4. A health professional dimension.

The two dimensions are connected and each others prerequisites. The information technology dimension is not a goal in itself, but a means to better health benefits that meets a need among citizens, patients and health professionals. The idea is to move away from a centralised model with highly specialised medical professions who treat patients in hospitals. In stead, the vision is to construct a more decentralised model in which the individual plays an active role in taking

care of his or her own well-being The types of technology that are pointed at research within the concept of pervasive healthcare can be characterised as support technologies aiming to help citizens remain healthy both physically, mentally and socially [8;9;13;15].

The movement from information technology to support technology can also be used when developing pervasive technologies for health professionals in a hospital. In these cases the most important issue is not information processing (such as electronic health records) , but assisting health professionals in their daily work by means of embedded, wireless, mobile technologies inside the hospital's walls. The focus is:

1. to create computer support embedded in the physical environment of the hospital

2. to create context-aware applications[1]

3. to support mobility and collaboration.

In this sense, pervasive healthcare also contains a range of possibilities on the organisational level. Examples of this would be improved communication, better coordination, increased knowledge sharing and the easing of working procedures. At the same time, access to shared data and the opportunity to replace bureaucratically forms of cooperation with more flexible forms of concrete data sharing and coordination will also ease the collaboration across units and areas of profession [8;15]. As Bott states in his article 'The Challenge of Ubiquitous Computing in Health Care': "Helath care seems to be an ideal application field for ubiquitous computing. Where else is the paradigm of "getting the right information at the right time at the right place" of greater importance than in health care?"[17]. Morán describes the vision about the hospital as a pervasive computer environment in this way: "it is a vision of a highly interactive workplace, where hospital staff can ascess relevant medical information, trough a variety of heterogeneous devices, and can collaborate with colleagues taking into account contextual information"[1].

1.2.3 Report from the Danish Board of Technology

In 2006 the Danish Board of Technology released a report by the title 'Health benefits with IT – Pervasive Healthcare in the Danish health sector'. With reference to the organisational and technological challenges that the health sector is facing, the Danish Board of Technology has in the period of September 2005 till May 2006 sought to clarify the impact the concept of pervasive healthcare is likely to have on the future health care sector. The purpose of the project was to define the concept of pervasive healthcare, to discuss what the concept covers and to illustrate possibilities and challenges by means of a range of cases. The report from the Danish Board of Technology was concluded with some general assessments and recommendations in correlation with the use of pervasive healthcare within the Danish health care sector [15]. See textbox 1.

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[1] Within computer science, context-aware applications refer to the idea of computers both being able to sense and respond on the basis of the environment they are in. Context-aware applications can also attempt to make assumptions about the user's situation during the use of the computer [16].

Textbox 1: Assessments and recommendations from the Danish Board of Technology

Assessments of the working group:

- Pervasive healthcare is part of the solution of the future challenges of the Danish health sector

- Denmark has good preconditions to develop and benefit from pervasive healthcare

- Significant organisational challenges are related to implementation of pervasive healthcare

- Pervasive healthcare presupposes common standards and it will gain considerable advantages from a national well-functioning electronic patient record structure

- Pervasive healthcare provides increased opportunity for individualised health benefits.

Recommendations of the working group:

1. Pervasive healthcare should be made a national and regional political focus area

2. A systematic collection and exchange of national and international experiences with pervasive healthcare should be initiated

3. A series of lighthouse projects ought to be initiated

4. Focus should be on the organisational challenges that the implementation of pervasive healthcare induces

5. Descriptions of technical and semantic standards in relation to pervasive healthcare ought to be initiated

6. Pervasive healthcare should be included as an integrated part of the work with electronic records

7. New technologies and standards in binding partnerships between the health care sector's institutions and the business community ought to be developed

8. It should be ensured that data exchange etc. is in accordance with existing legislation and security practice, and necessary legal frameworks are established in the case of innovations

9. A coordinating unit for pervasive healthcare ought to be established.

1.3 Objective and demarcation

In connection with the implementation of iHospital, the management of Horsens Regional Hospital has requested the completion of a health technology assessment (HTA) in correlation with the consequences of the implementation of iHospital in the surgery ward and its collaborating units.

Hence, This HTA report is based on the changed conditions in planning, coordinating, communication and information management that the implementation of iHospital is presumed to have produced.

The objective of the report is to examine if the implementation of iHospital has lead to a more efficient organisation concerning its execution of the daily surgical programme and the surgical ward in general. Likewise, it is aimed to clarify the staff's use and opinions of iHospital.

The HTA contains:

- A description of the technology (iHospital)

- A description of the data collection methods applied and their theoretical analytical framework

- A review and an analysis of the current organisational situation with regard to the implementation of iHospital

- An economic analysis of productivity in connection with the implementation of iHospital

- Patient aspects in connection with the implementation of iHospital.

Each chapter contains subsidiary goals and analysis questions that specifies and clarifies the overall objective.

As mentioned in textbox 1 above, the Danish Board of Technology put forward different assessments and recommendations in connection with the report 'Health benefits with IT – Pervasive Healthcare in the Danish health sector'. The four initial recommendations point at areas which, to a greater or lesser extent, are supported in the work with the HTA report of iHospital at Horsens Regional Hospital.

1. Because HTA reports are primarily intended as input for political decision processes, an HTA report will have a good opportunity to increase the political focus on the examined area, corresponding to recommendation number one from the Danish Board of Technology.

2. To complete an HTA study of iHospital is part of the process towards a systematic collection and exchange of national and international experiences with pervasive healthcare, which the Danish Board of Technology recommends be launched.

3. The project with iHospital per se is said to be a 'lighthouse project'. Additionally, it is rarely seen that the implementation of a new IT system is followed up by systematic knowledge collection such as an HTA study. The Danish Board of Technology emphasises the utility of lighthouse projects to facilitate the development of pervasive technologies within the health care sector.

4. An important part of most HTA studies is to examine the organisational context and the organisational conditions in connection with the implementation of new technology. Likewise, the organisational perspective constitutes a central aspect of the report's analyses in this HTA study of iHospital. The Danish Board of Technology points to the importance of focusing on the organisational challenges of implementation of pervasive healthcare.

In 2008, Orwat et al. issued a review about pervasive computing in the health care sector. 67 different pervasive systems within the health care sector are described in 69 articles in this review. In the review, the systems are categorised on the basis of various parameters, but especially two statements are interesting in the light of the Danish Board of Technology's recommendations about the actual content of an HTA study. In the review, it is concluded that even though organisational and financial aspects of system implementation are important elements for the system's future success, these elements are rarely addressed in the articles. Only 10 out of the 69 articles mention financial aspects in connection with system implementation and none of them make a comprehensive analysis of the expenses and benefits of system implementation [12].

The latter five recommendations of the Danish Board of Technology are closer related to the design of technologies and the technical development of different pervasive systems. Consequently, the work of this HTA report does not directly support these areas.

1.4 Method

Several of the selected data collection methods in this HTA cut across the different analyses. These both include data collection methods and theoretical analysis frameworks to support the analysis of the collected data.

The selected data collection methods are:

• Systematic literature search and review, plus review of different documents and various grey literatur.

• Observational study at Horsens Regional Hospital.

• Time registration in the operating rooms.

• The completion of a questionnaireamong all employees who use iHospital.

• Interview with relevant key figures.

• Extraction of register data.

• Qualitative review of unintended events.

The theories selected to support the analysis of the collected data are:

• The sociotechnical understanding of the interplay between technology and organisation/people

• The significance of awareness for the work in large hospitals

- Mintzberg's theory about various organisation models and their embedded coordination mechanisms.

For further information about the applied methods, please refer to the report's overall method section.

1.5 Project organisation

The composition of the project group is as follows:

- Lotte Groth Jensen, project manager and documentalist, MSc in Sociology , HTA and Health Services Research, Central Denmark Region

- Merete Bech Bennestsen, HTA consultant, MSc in Public Administration, HTA and Health Services Research, Central Denmark Region

- Lars Ehlers, health economist, MSc in Economics and Management, PhD, HTA and Health Services Research, Central Denmark Region

- Thomas Riisgaard Hansen, PhD, postdoc, Centre for Pervasive Healthcare, Aarhus University

- Claus Davidsen, Head of Planning, Horsens Regional Hospital

- Birgitte Bigom Nielsen, innovation consultant and project manager, Horsens Regional Hospital.

In excess of the project group, a steering group was associated to observe the preparation of the HTA report. The composition of the steering group is as follows:

- Mette Kjoelby, Head of Department, DDS, PhD, Clinical Associate Professor, HTA and Health Services Research, Central Denmark Region

- Steen Friberg Nielsen, Hospital Medical Director, Horsens Regional Hospital

- Jakob E. Bardram, professor, MSc, PhD, The IT University of Copenhagen

- Joergen T. Lauridsen, professor, MSc in Mathematics-Economics, PhD, The Health Economics Research Unit, Institute of Public Health, University of Southern Denmark, Odense.

1.6 The challenges of completing health technology assessments of IT systems

In connection with the completion of an HTA of an IT system, a series of challenges occur which do not to the same extent apply to health technology assessments of more traditional technologies within the health care area (such as medicine, treatment methods, surgical procedures etc.).

Unlike HTAs of other technologies, an IT system's area of activity is rarely proven by comprehensive, preceding testing, as is often the case with e.g. random studies of medicinal products. It is difficult to find assessments or information about IT systems in the literature that can provide a certain guarantee of how these systems function when they are implemented in a working or-

ganisation. Compared to other technologies within the field of health care, there will often be a significant difference in the size and/or the kind of effect expected from the implementation of new IT systems [18;19].

An additional challenge when completing HTAs on IT systems originates from the tendency of these systems to change rapidly over time. When a development or implementation project is conducted over a long period of time, technical changes in practice often make it impossible to avoid making changes in the IT system during the process. This is in evidence, regardless of the demands of the system being fixed in advance in a specification requirement. The uttermost consequence is that development and implementation projects are indeterministic (unpredictable in every detail) and change dynamically. Usually, there will be at continuum of variants between the extremes 'indeterministic' and 'deterministic', respectively 'dynamic' and 'static'. Only a few aspects will change, while others are completely static [18]. Additionally, it will often prove difficult to separate the impact of the implementation of a new IT system from other factors influencing influence the development of an organisation.

Finally, it can be difficult to determine which methods are most suitable for analysing issues about the implementation of IT systems in organisations. Results from economic analyses and random, controlled clinical tests exist, but these studies only address a limited section of the questions that ought to be asked in connection with the assessment of IT systems [18;19]. Accordingly, a broad methodical approach ought to be applied when studying the implementation of IT systems in organisations.

2 Technology

2.1 Course of development of iHospital

2.1.1 Research

The first complete book about the use of pervasive technologies within the health care sector was published in 2007. The book, titled 'Pervasive Computing in Healthcare', introductorily remarks that if pervasive technologies are to be applied successfully within the health care sector, it is necessary for the design and development team to have a profound understanding of the users and the environment in which their systems are to be implemented. Ideally, the development of pervasive technologies within the health sector accordingly involves a wide group of professions. It may concern physicians with different specialities, nurses, nursing staff, therapists, engineers, computer specialists, 'human factor professionals', industrial designers, patients and citizens according to the purpose of the system [8;9]. In the development of iHospital, the attempt has mainly been to comply with these ideals about user involvement and user-driven innovation.

iHospital began as a research project in the middle of 2003 in a collaboration between Centre for Pervasive Healthcare at Aarhus University, Horsens Regional Hospital, Medical Insight A/S and Danish Data Display A/S. The project was financed by ISIS Katrinebjerg, a Danish competence centre. The objective of the research project was to study, develop and test new types of pervasive computing technologies and health care IT systems that could support the health professionals' daily work. The systems should attempt to create a better overview, better communication and better coordination in the patient courses. From the start, a series of decisions were made to outline the project:

- The project should not concern the Electronic Patient Record (EPR). Despite the many challenges of the EPR, the core attitude was a great interest about EPR and many who already worked with it. For that reason it was assumed that EPR was developed and implemented. In stead, focus was placed on some of the issues in hospitals that EPR did not cover directly.

- The project's purpose was to study how technology could be designed if the starting point was the daily clinical work and not administrative office work.

- The project had to work with IT in the surgical ward, since this was a place where tasks differed significantly from administrative office work. If the project succeeded in the surgical ward, it would surely also be successful in other sections of a hospital.

- The project was to focus on overview and communication. In an earlier project called 'social awareness' in the former Aarhus Municipal Hospital, a series of challenges in connection with overview and communication were identified. There was a wish to pass on this experience in the new project about iHospital.

At the same time in 2003Horsens Regional Hospital was working on the preparations for constructing a new day surgery centre. Therefore, new inspiration regarding interior arrangements was sought. The focus of this process was logistics regarding patients, staff and instruments. In connection with this work, working procedures were analysed. From these analyses a need for an IT system that could assist the health professionals' daily work in their effort to keep overview, create good and useful communication, and facilitate a smooth coordination emerged.

Initially, an interdisciplinary working group from Horsens Regional Hospital was established consisting of a Hospital Medical Director, some chief surgeons, an anaesthesiologist, a secretary, a staff nurse, some surgical nurses, some nurse anaesthetists and a service assistant. This internal working group from Horsens Regional Hospital collaborated with Medical Insight, Centre for Pervasive Healthcare and Danish Data Display in developing ideas and creating concepts for new pervasive computing systems.

This idea development continued in 2004 with the conduct of workshops of varying focus. A total of three workshops were held with 10 to 12 participants from Horsens Regional Hospital. These workshops took their starting point in exploratory adaptation thinking and the process was characterised by user-driven innovation. User-driven innovation focuses on the great innovation potential that lies within the user. The type of user-driven innovation that was used in this development work is called employee-driven innovation and above all it is based on the great practical knowledge which those who are closest to the task solving can bring into play to find new solutions [20]. The objective with the workshops held was to create idea development, product development and also to look at the design of user interfaces. Additionally, focus was on a potential streamlining of working procedures by conducting analyses of these seen in relation to the patient pathways and internal logistics.

During 2005 Centre for Pervasive Healthcare developed the first prototype which primarily focused on creating overview, communication and coordination. The prototype consisted of three central components: (i) big interactive screens providing an overview of staff, surgeries and communication; (ii) mobile phones with the same access as the big screens plus telephony; and (iii) tracking of health professionals by the means of Bluetooth technology. The prototype was installed in the central operative suite, in the recovery ward and in a surgical unit. The work situation in the central operative suite changes from one moment to the next because of acute patients, illness among the staff, prolonged surgeries, patients who fail to appear etc. It was important for the project group to investigate whether or not the system was able to support the clinical reality in an environment like that.

In December 2005 iHospital was technically tested and placed in pilot test in the central operative suite. After four months of testing, the original research project came to an end and it was intended that the IT system should afterwards be taken down again. However, the staff of the Horsens Regional Hospital wanted to keep the new system. Consequently, a small company – Cetrea A/S – was established and started a product development process of a system based on the iHospital concept. Every research result, including their underlying technologies, was made available to the public.

While the development of a solid product version was underway, the original research prototype stayed in the central operative suite.

2.1.2 Development

iHospital stayed in the central operative suite while the further development gained ground. The development was addressed with an exploratory, adaptive management approach with a starting point in user-driven innovation. Three workshops with cross-disciplinary representation from Horsens Regional Hospital were held. The project group was extended to include staff from the surgical wards, the recovery ward and the central sterilisation department. These employees were included because each of them had an active role in the patient pathways.

In the beginning of 2007 the management at Horsens Regional Hospital decided that a health technology assessment should be conducted in connection with the implementation of iHospital

as a permanent technology. Therefore HTA and Health Services Research, Centre for Public Health, Central Denmark Region, the researchers behind iHospital and central employees at Horsens Regional Hospital collaborated with the purpose of producing the health technology assessment.

In 2007 a new version of iHospital was ready for pilot testing. The focus was directed towards integration with the booking system BookPlan. The day surgery centre started developing a booking module tailored to their needs, and thoughts about integration between BookPlan and iHospital gained ground. The integration between the two IT systems was established, and the development happened on the basis of an ideal about user-driven innovation. In that connection, two workshops were held concerning the further development of iHospital and integration with BookPlan.

In the middle of 2007 iHospital was put into operation in its new product version both in the central surgical ward and in the day surgery centre. Integration with BookPlan was implemented in the day surgery centre from the start and in 2008 it was integrated in the central operative suite.

To sum up, the selected design approach for the development of iHospital has been a user-driven, participative process in which health professionals have participated in the entire process. In the beginning, the health professionals participated in identifying key issues in their work which technology could potentially eliminate. Among other things, they pointed out that overview, effective coordination and smooth communication were relevant focus areas. Later in the process, the health professionals were actively involved in discussing different design suggestions and selecting those that had the biggest potential in correlation with the work processes. Finally at the end of the design process, the health professionals were involved in testing the prototypes and giving feedback about the specific system design. After the system has been implemented, the health professionals have regularly been giving feedback and commented on improvements and modifications of the system. In all, the process has approximately been 4 ½ years underway from the first exploration of the idea in 2003 until complete implementation in 2007, , and the system development still continues.

2.2 Working conditions in the surgical ward

2.2.1 Execution of surgical programmes

A core activity in modern hospitals is the surgical ward. The surgical ward is either a separate unit divided between a series of specialties or an integrated part of a special unit. Typically a surgical ward consists of between 2-15 operating rooms. Each operating room is a critical and expensive resource, and to ensure an optimal use of the operating resources, these rooms ought to be in use constantly during the daily opening hours (with the exception of rooms reserved for special acute activities).

Optimal utilisation of the operating rooms requires that the actual operative period and the turn-around between surgeries are optimised. Furthermore, all resources needed for an operation must be available without any delay. To make this succeed, the patient must be prepared, the instruments must be clean and ready and nurses and qualified surgeons must be ready at the right time. Activities outside the surgical ward are also affected. An optimal utilisation concerns activities in the ward, recovery ward, central sterilisation department, intensive care unit and acute reception.

2.2.2 Deviations from the programme

Scheduling can help to solve many challenges in surgical wards, but the execution of a surgical programme which can also include acute patients almost always involves a series of unforeseen events which require immediate adjustment in correlation with the programme. The following events often require immediate adjustment:

- Acute patients: An acute patient may require operations resources be moved from the planned surgical programme to the acute pathway. This may for instance occur at traffic accidents or acute Caesarean sections.

- Changes in staff situation: A key figure, for instance a surgeon, is missing. Perhaps due to illness, another activity that progresses more slowly than expected or other sections of the hospital that require an activity of high priority from this person.

- Changes in the patient's situation: A patient can have a relapse, may have forgotten to fast, fail to appear or the like. Consequently the patient cannot have the surgery and this will result in changes in the surgical programme of the day.

- The operating room is not available: The preceding operation is drawn out exceeding the allocated timeframe. This may include both routine surgeries that suddenly turn out to be more complicated and surgeries of which the duration is difficult to determine beforehand (for instance, if it is necessary to wait for results from the laboratory before the surgery can be completed). However, the opposite can also be the case, for instance that the operating room is finished ahead of schedule.As a result the programme can be advanced if possible.

- Communication errors: Another important possible cause of delay is communication errors. Among other things, thismay concern that the ward has not been informed to prepare a particular patient, a surgeon not calculating on having to perform surgery at the relevant time, the central sterilisation department not having the right equipment ready, the cleaning staff not being informed that the operating room is empty, a nurse having prepared for the wrong operation, etc.

- Coordination errors: The coordinator has inadequate information or information containing errors which results in undesirable decisions being made. The coordinator may not be aware of a certain surgeon who needs to leave early or surgeries being swapped between surgeons at a time when the coordinator was not present and as a result lacks information about this.

- Other: There can be many reasons for changes in the surgical programme of the day, for instance technical failures, strikes, MRSA (staphylococcal infection) etc., which may affect the planned programme.

2.2.3 The management of deviations

The surgical ward often has a coordinator associated to handle challenges like the above mentioned. This coordinator is responsible for adjusting the surgical programme of the day to any new circumstances and to inform the people who are affected by these changes. This coordination often involves a series of steps:

- Problem identification: The coordinator must be aware there is a problem in correlation with the planned surgical programme. The coordinator may e.g. receive information from the operating rooms that they will not be ready on time.

- Solution identification: Possible solutions must be identified. Is it possible to move the upcoming surgery to another operating room? Is there another surgeon available to complete the surgery? etc.

- <u>Solution verification:</u> After a possible solution has been identified, the solution's durability is tested. The choice of test procedure depends on the type of problem. For instance, it may concern that an alternative surgeon is being contacted, that the ward must be contacted with the purpose of quicker preparation of another patient, that the anaesthetics department must be contacted, that it must be checked if the equipment is ready from the central sterilisation department etc.

- <u>Announcement of changes:</u> If the solution proves to be durable, the change must be announced to every relevant part. First and foremost it concerns nurses, surgeons, anaesthesiologists, wards, the central sterilisation department and the recovery ward. That is, all parties must be aware that from now on a changed surgical programme is being used.

Even though the steps are listed in a logical order, the actual coordination of them is often more complex and involves leaps back and forth between the different steps and it is often necessary to respond to several issues at the same time.

To support the communication and coordination tasks related to the execution of the daily surgical programme a series of technological solutions are typically used.

2.3 Paper-based programmes, whiteboards and the telephone

In order to create an overview of a working day's surgical programme and its possible changes, hospitals often use a print of the daily programme taken from the booking system or the whiteboard that the programme is written on.. In the surgical ward there is often a master document or a board on which the current programme appears, and more or less updated copies of this programme are often placed on various places in recovery the ward, ward, or even as printouts in the pockets of the health professionals.

Printout of a surgical programme

It is usually the above mentioned coordinator's task to make sure that the master document or board is constantly updated. This involves identifying issues, finding solutions, verifying solutions and announcing changes. At his or her disposal, the coordinator often only has a whiteboard, a programme printed on paper and a telephone. Additionally, the coordinator often visits the different operating rooms and perhaps looks through the peephole or the window to see how far along the surgical procedure is. The coordinator also uses the telephone and direct face-to-face communication to identify changes in the surgical programme. Subsequently, direct communication or telephone is used to identify and verify solutions and to announce changes.

Typically, the coordinator records changes in the daily surgical programme in the master document by means of markings on the paper-based programme, e.g. a felt tip line to highlight that an operation has been initiated, a "ballpoint-patient" written at the bottom of the page in the event of new acute patients, a digit beside each patient's name in the event of change in the sequence etc. These changes are announced to the relevant parties as needed, often by means of the telephone or personally. Other areas of specialty which are only partially affected by the changes will often not receive the information until they themselves contact the coordinator.

The benefits of using paper-based programmes and whiteboards are that it is very easy for the coordinator to make the changes on the board/paper and that the solution is robust (that is, not dependent on a technological infrastructure). The drawback is that the overview rests only with the coordinator and in no other places in the hospital. Additionally, it can be difficult at times to read symbols and letters because these often are written in handwriting in situations where time is a limited resource.

The telephone is also a robust technology and has the advantage of enabling quick replies on questions. The disadvantage of the telephone is that it is very disturbing each time the receiver of a telephone call has to stop the current activity to answer the phone. It is also a slow communication method if a message quickly needs to reach many people and the coordinator's telephone will often be busy with other conversations, thereby obstructing further input.

2.3.1 Overview, communication and coordination

To sum up, the use of traditional technology for execution of surgical programmes, which also include acute patients, has identified three main issues:

1. Lack of overview

2. Lack of effective communication

3. Lack of smooth coordination.

This leads to the following assumptions:

o A better overview will assist health professionals to identify possible complications in the daily surgical programme more quickly and subsequently help to find effective solutions.

o Better means of communication will help to inform health professionals about changes in the daily surgical programme quicker and more affectively and to reply to occurring questions quicker and more effectively.

o Better support of the coordinating work of health professionals will provide a better use of resources in the event of many programme changes and acute patients.

2.4 The technology behind iHospital

The technology behind the current version of iHospital is a versatile combination of a series of different pervasive computing technologies. A series of technologies applied from the research project are of a complexity which makes it difficult to scale them up directly. Consequently, some of the technologies will not be completely rolled out in Horsens Regional Hospital until 2009. These technologies have a brief note attached.

2.4.1 Overview

In the following, a series of the technological initiatives which contribute to increasing the overview of the hospital staff is described briefly.

2.4.1.1 Informative and interactive monitors

A requirement for the technology in order to ensure a quick overview is that the technology is fast to learn and fast to use. If it takes too much time to get the overview, the benefits of being constantly updated disappear. To support an extremely quick overview, the technology is tailored to run on monitors that are on at all times and not running any other programmes. Among other things, this means that the monitor display that health professionals see is the same each time they pass the monitor and that the information on the monitor is carefully selected in order to match the health professional's needs and avoid spoiling the overview with too much noncritical information.

The interactive big screens from iHospital feature much different information which is immediately visible and can be seen by health professionals without them having to perform an action. That is, this information is always available on the monitors.

2.4.1.2 Module-organised clients
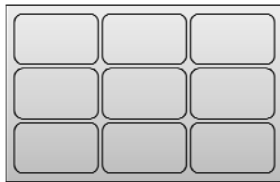
The type of overview needed by health professionals depends very much on their job position in the hospital (for instance, the ward, the surgical ward, the central sterilisation department or the recovery ward), and also on which fields of specialty who use the monitors. To meet these changing needs, the system is organised in a series of modules or blocks which health professionals can combine based on their current need for information and overview of the different locations in the hospital. What is relevant to the ward is not necessarily relevant to the coordinator in the surgical ward. The coordinator requires the extensive overview of all resources (staff, operating rooms, surgical equipment etc.), patients and the execution of the daily surgical programme. The ward only requires information on the execution of the daily surgical programme in order to prepare and track the patients. Therefore, the overview is best maintained if each function is only presented with the precise pieces of information relevant to it.

2.4.1.3 Different sources of content
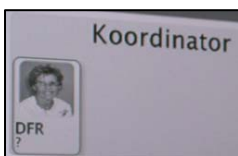
An effective overview requires access to many different types of information, for instance the daily surgical programme, which health professionals are available, when they are off, where the patient is, if the patient is ready etc. This information is gathered in, iHospital which integrates a series of different information sources in specialised components of overview and modules, for instance, operating room, staff and patient health records. In this way, the monitors from iHospital present a unified overview of this information.

2.4.1.4 Tracking of staff and patients

In order to be able to reach health professionals qyickly in the event of changes in the surgical programme, the system allows for them to be tracked. The tracking is based on zones. That is, the hospital is divided into a series of zones that registrate when a certain person enters a certain room, e.g. when a surgeon enters an operating room. Movements from one zone to another are registered and information about the surgeon's whereabouts is attached to the information on the operating room so that

anyone watching the monitors from iHospital can see that the surgeon is in the operating room. When the surgeon leaves the operating room, the information on him disappears on the screens and reappears when heenters a new tracking zone, e.g. the ward. In this way, an overview of where health professionals are positionedis ensured, and this makes it easier to reach them if changes occur in the surgical programme. A certain form of tracking technology, which was difficult to scale up, was used in the research project behind iHospital, and in the product version a new and more more scalable tracking mechanism was introduced. However, this technology was not being used in the period of which this HTA study was conducted.

2.4.2 Mobile overview

A client for mobile phones was developed in the research project in order to support the mobile reality of health professionals. From this point the health professionals could communicate with each other while at the same time forming an overview of the daily surgical programme, because parts of the monitor display from iHospital were also visible on mobile phones. A new web-based version is developed in the product version which is put into operation at the beginning of 2009. However, this technology was not used in the period of which the HTA study was conducted.

2.4.3 Communication

As a supplement to speech communication iHospital contains a series of functions that support communication in other ways.

2.4.3.1 Video

Cameras providing live video feed to the monitors of iHospital are placed in the top corner of every operating room. This video feed supports a visual communication in which the staff can see whether or not an operating room is empty, a nurse is preparing for the next surgery, the anaesthetics have begun, an operation has started, there is a break in the surgical procedure, a patient is about to leave a room, a room is being cleaned etc.

2.4.3.2 Chat

A chat function built into iHospital makes it possible to write text messages between the coordinator central, the operating rooms, the ward, the recovery ward and the central sterilisation department. When a message arrives, the computer makesa short beep and the monitor starts blinking slowly until the message is replied to. This chat function hereby enables a means of communication that is less disturbing than the telephone. The telephone requires an instant reply in order to provide the opportunity of communication.

2.4.3.3 Communication for mobile units

During the pilot testing of iHospital, chat messages could be sent directly to the health professionals' mobile phones. In the commercial version, a proof of concept demonstration of the pos-

sibility to send messages to both PDA's and DECT-telephones was performed to enable the system to be used by health professionals who are not allowed to carry mobile phones. This expansion is scheduled to launch in 2009 and has thus not been used in the period of which this HTA study was conducted.

2.4.4 Coordination

Essentially, coordination of the daily surgical programme deals with transforming overview into action. A central concept is in this context is interaction.

2.4.4.1 Interaction

 All components in iHospital are designed to provide a first hand overview of the current situation in the hospital. The majority of interaction opportunities (buttons) are hidden on the user interface, but when an active act is initiated, interaction opportunities which make it easy to go from overview to action appear. For instance, surgeries can be moved in the surgical programme (rebooking) by dragging on the interactive monitor, and in the same way surgeries can be moved from one operating room to another. The status and roles of the staff can easily be updated and a patient's status can also easily be changed. In this way, coordination and interaction become an integrated work process. The changes made in the surgical programme through monitor interaction concerning staff status, patient status, etc. from iHospital, can likewise be seen instantly on every monitor in the entire hospital.

2.4.4.2 Interactive, pressure-sensitive monitors

Because iHospital is often used in situations where health professionals are busy, a big part of the interaction is designed to work with pressure-sensitive monitors. These differ from conventional interfaces in which they make on interaction. Scroll buttons, check boxes and similar components do not work well on pressure-sensitive monitors, and small buttons may be difficult to hit. Consequently, special techniques in iHospital have been developed to support touch, such as the use of special interaction components and scrolling.

2.4.4.3 Different coordination needs

Dependent on the agreed working procedures, there is a clear division of responsibilities between who is allowed to declare patients ready, who is allowed to change the surgical programme, how the prioritisation of the acute patients takes place etc. iHospital supports the possibility to configure which coordination options the different monitors can have. In other words, wards are able to report acute patients to the surgical ward, but they cannot change the prioritisation of acute patients. Other arranged work processes can likewise be supported by the technology.

2.5 Other technical concepts

Among other more technical concepts behind iHospital, it can be mentioned that the entire system is based on so-called push technology. Normally, programmes ask a server about changes (pull technology), but iHospital uses push technology in order to quickly inform about changes. This means that a message is sent to all interested clients as soon as a change occurs.

Another technical building block is the user interface which is constructed in scalable graphics. In other words, the system is designed to look appealing and to be used both on big monitors, average size monitors and small units.

For video streaming, peer-to-peer technology is used to distribute the video to the clients who are signed up for video streaming without burdening the network unnecessarily.

The system is also designed to make backups of the data used. A pdf file of the current status in the surgical ward is generated at regular intervals and sent to a computer attached to a local printer. The most recent programme can always be printed out from this computer in the event of a crash of the entire hospital network.

2.6 The technology recapitulated

To sum up, the technical solution behind iHospital consists of a series of technologies which are all developed to support one or more of the challenges that health professionals face as a result of the request of effective and quick execution of the daily surgical programme. Among other things, it concerns an effective overview, a portable overview, effective communication and easy and fast interaction. The possibilities of iHospital is summarised in brief in the points mentioned below. Hence, iHospital provides the following possibilities:

- to create an overview of booked surgeries, resources and patients in every operating room.

- to show status information on surgeries and patients accurately and in real time.

- to provide other departments with an overview of the status in operating rooms related to these departments, such as wards, recovery ward, emergency ward and central sterilisation department.

- to communicate through text and speech – through big monitors and portable clients.

- to show live video from operating rooms and coordinator rooms.

- to provide an overview of the staff: who is working, who has got which shifts and what are they doing at the moment.

- to locate staff.

- to handle acute and cancelled surgeries.

- to ad hoc plan and handle deviations on the actual day of surgery [2]

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[2] More about the technology can be read in the following articles:

Hansen, Thomas Riisgaard, Bardram, Jakob E.
"Applying Mobile and Pervasive Computer Technology to Enhance Coordination of Work in an Surgical Ward"
Published: Proceedings of MedInfo 2007, MedInfo: 189-200.

Bardram, Jakob E., Hansen, Thomas Riisgaard, Soegaard, Mads.
"AwareMedia - A Shared Interactive Display Supporting Social, Temporal, and Spatial Awareness in Surgery"
Published: Proceedings of the Computer Supported Collaborative Work 2006, ACM Press
doi: http://doi.acm.org/10.1145/1180875.1180892

Bardram, Jakob E., Hansen, Thomas Riisgaard,
"The AWARE Architecture: Supporting Context-Mediated Social Awareness in Mobile Cooperation"
Published: Proceedings of the 2004 ACM conference on Computer Supported Cooperative Work, ACM Press: 192-201.
doi: http://doi.acm.org/10.1145/1031607.1031639

2.7 Related systems

iHospital is directly pointed at the planning and execution of patient pathways and integration of overview, communication and coordination. Within this field no similar systems exist. The closest related systems are a combination of the use of whiteboards, printed surgical programmes and or booking systems and telephones. On a research level systems which have employed video for filming whiteboards at the coordinator and showing this picture around the hospital exist. Other systems have worked with lamps that glow differently depending on the status of the operating room.

The concept behind iHospital is to gather all information related to overview, communication and coordination of the daily surgical programme and present to it to health professionals. As a result, iHospital collaborates with a series of systems, such as patient administrative systems, patient records, booking systems, alarm systems, telephone systems, staff management systems, tracking systems, "nurse finders" and others. Accordingly, each of these systems can be viewed as having related functionality to one or more of iHospital's parts, but none of them support communication, overview and coordination directly.

3 Overall method section

In relation to to the content of the thesis it is considered necessary to use several different methods in an assessment and evaluation of IT systems implemented in the health sector. In his article "patient care information systems and health care work: a sociotechnical approach", Marc Berg points out that quantitative objectives such as user satisfaction and time studies can be useful when evaluating IT systems, but also that it is necessary to let qualitative data form part of the various analyses in order to make quantitative and qualitative data supplement each other to provide a better understanding of the results discovered. He argues that qualitative methods provide valuable knowledge to studies of changes in tasks, roles and division of responsibilities. As an example, he proposes that time studies can be made of various tasks, but if the nature of the task radically changes, the time studies lose their relevance and, consequently, other methods have to be used [21] In this way, in the handling of such issues it often makes sense to supplement quantitative methods with qualitative methods in order to test the accuracy, content, validity and relevance of the data gathered by the quantitative methods [21;22].

The case study has been selected as methodical starting point for this HTA. The case study method is a research approach that focuses on the circumstances, the dynamics and the complexity of a single case. The case is studied intensively, and often several different methods are used in order to study the complexity and validate the results. It is a good method when wishing to study complex social settings, and it is especially valuable in the examining and early stages of a study [22].

No research methods are completely clear of bias, but when a hypothesis has been confirmed by means of more than one procedure of measurement (method approach), the uncertainty concerning the accuracy of this is reduced. As a consequence of this, and with the case study approach as the basis, this HTA study uses method triangulation (the use of three or more methods to clarify the same issue) [22]. For the study, seven different methods for overall data gathering were selected. Data gathered by means of these seven methods are used across the report's different chapters and analyses. The seven data gathering methods are:

- Observations conducted in the central surgical ward and collaborating units in Horsens Regional Hospital.

- Interviews conducted with different areas of specialty in Horsens Regional Hospital and central key figures behind the development of iHospital.

- Questionnaires conducted among all staff who use iHospital in Horsens Regional Hospital.

- Time recordings conducted in every operating room in the central surgical ward in Horsens Regional Hospital (excluding the day surgery centre).

Register study with extracts from eSundhed[3], Silkeborg Løn[4], the financial system ØS2000[5] and the hospital's budgetplan.

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[3] "eSundhed" is an information system which facilitates communication about financing, accounting and the underlying hospital activities based on the DRG-system.

[4] "Silkeborg Løn" is the region's wage- and HR-system.

- A quantitative assessment of unintended events submitted to the Danish Patient Safety Database.

- Literature assessment.

The methods for data collection used will be described in more detail below.

3.1 Observations

In the spring 2008, observations with particular focus on the central surgical ward were performed in Horsens Regional Hospital over the course of three working days. These observations were conducted by two researchers from HTA and Health Services Research. The observations were conducted with a broad definition of the concept of observation as the starting point. Observation is here understood as a direct collection of information carried out by means of the researcher's senses. Observation is seen as a research method in which the researcher systematically observes, listens and documents interesting phenomena. The potential for observational bias, meaning that the observer reports interpreted data in stead of reporting the actual event, is always present in observational studies [22]. In this study, observational bias is sought to be reduced by the attendance of two observers.

The main focus of the first day of observation was pointed at the activities that take place in the surgical ward around the 'coordination central'. The coordination central is the physical location in the surgical ward where the coordinators mostly are when they are on duty as responsible coordinators. At this location the big pressure-sensitive monitors from iHospital are positioned, and other staff members usually address this place if they have questions regarding the surgical programme of the day. These enquiries can either be made by means of telephone, chat messages or by physically showing up in the coordination central. In this way, the coordination central works like a nerve centre with much activity in the surgical ward.

In the following two days of observation, the researchers from HTA and Health Services Research wore scrubs in order to be able to observe everywhere in the surgical ward, including the operating rooms. Timewise, the majority of the observations were conducted in the surgical ward and the affiliated operating rooms, allthough shorter observations and conversations with staff members of affiliated departments also were conducted (central sterilisation department, recovery ward and wards).

3.1.1 Objective of observations

The main objective with the conducted observations was to identify working procedures and tasks where staff members used iHospital. Thus, the focus was on researchíng the staff members' use of iHospital, and not a systematic registration of when and how often the staff uses iHospital. The observations were not meant to provide a comprehensive image of the use of iHospital but primarily to work as an inspiration for subsequent development of questionnaire, interview guides and analyses. The observations gave a good understanding of the working procedures in the surgical ward.

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[5] "ØS2000" is the region's system supporting financial management.

3.1.2 Observational methods

To support the observations, a registration form in which the different working procedures could be registered and described in correlation with relevant parameters was developed prior to the observations.. It was not possible to fill out the entire registration form during the actual observations. Consequently, the registration forms were filled out after each observation by means of notes made during the observations and discussion between the two observers.

By using this method the observers had one particular focus, namely working procedures and tasks in which iHospital was used. Notes were made during the observations concerning these working procedures. In addition, the researchers also recorded additional events which were at the time regarded as significant for the thesis of the study.

The observations were conducted as a mix of structured observations and a more open approach [22;23]. On the basis of both practical and theoretical prior knowledge about the field and interviews with central individuals in the project, it was given beforehand that working procedures and the use of iHospital was the focus of the observations. However, it was not defined beforehand which working procedures should be observed, just like further interesting and informative observations were not left out of the final material beforehand.

3.2 Interview

For the use of several analyses in the HTA study, 11 interviews with relevant individuals within the project on iHospital were conducted. A total of 16 individuals were interviewed. A summary of the 11 interviews is seen in table 3.1.

Table 3.1 Participants in the conducted interviews

Area of specialty	Number of interviews
Surgical coordinator	Two interviews, each with one coordinator
Surgical nurse	Two interviews, each with one nurse
Anaesthesiologist/Chief physician	One interview with one physician
Surgeon	Three interviews, each with one surgeon
Group interview: (wards, recovery ward and central sterilisation department)	One interview with five participants
Medical Director	One interview with one physician
Researcher behind iHospital	One interview with two individuals

The interviews were conducted as semi-structured interviews, and for every area of specialty an interview guide which treated the overall themes of the interview was developed. It was not precisely decided on beforehand which questions were to be asked and neither how the questions were to be formulated. However, the interview guide contained some quite specific subjects which were to be treated in the various interviews plus suggestions for question phrasing and opening questions within each subject. In its starting point, the interview procedure was intended to take place in a certain sequence, but at the same time there was a will towards changing the question sequence and form and thus establishing the opportunity to pursue the answers given by interviewees. Thus, the interviews' starting points were explorative and hypothesis testing [24].

All interviews were conducted by two interviewers, one having the primary responsibility for the completion of the interview in correlation with the interview guide set up. The task of the other interviewer was to formulate detailed questions and if suitable introduce new themes that might seem relevant in the light of the interview's progression.

Interviews with the different areas of specialty had different overall themes. Overall, the interviews dealt with themes such as:

- Thoughts and ideas behind the development of iHospital

- The purpose of the development of iHospital

- The development of iHospital

- Working procedures before and after the implementation of iHospital

- Working environment and iHospital

- Efficiency and iHospital

- Factors with decisive significance of how the surgical programme is assembled

- Planning of the daily surgical programme before and after the implementation of iHospital

Interview guides to the different interviews are brought in appendix one to six.

3.2.1 Transcription and analysis of interviews

The interviews were transcribed word for word and in full length for the use of the various analyses. Every interview was transcribed by the same person who has great experience with transcribing research interviews. The transcription took place on the basis of established rules about how pauses, incomprehensible talk, interruptions, punctuation etc. are to be marked in the text.

The actual analysis of interview data was primarily conducted as a content analysis in which a meaning condensation on the basis of the interview text was made. In other words, long statements were summed up in shorter statements rephrasing the main message in a few words. In brief, the content analysis contained the following steps:

1. Data collection

2. Statement condensation and grouping into relevant themes/categories

3. Analysis and presentation of condensed data.

To ensure reliability of the conducted content analysis, each interview was read through by at least two individuals. The categorisations made by the two individuals were compared and discussed after which a common theme/categorisation was found [22;24].

3.3 Questionnaire

To support more elements in the HTA study a questionnaire was conducted among staff members who use iHospital in their daily work at Horsens Regional Hospital.

3.3.1 Drawing up the questionnaire

The initial drafts of the questionnaire were developed in correlation with several central contact persons at Horsens Regional Hospital and individuals behind the development of iHospital. In addition, the questionnaire was developed on the basis of the conducted observations at Horsens Regional Hospital and interviews with relevant staff members.

Subsequently, the questionnaire was put through pilot testing with representatives from the relevant departments and areas of specialty at Horsens Regional Hospital. A representative from each department and area of specialty that were to receive the questionnaire was asked to read the covering letter and front page of the questionnaire and then fill out the questionnaire. After completing the questionnaire the individual was interviewed by a researcher from HTA and Health Services Research. The interview was conducted based on an interview guide set up beforehand in which each question in the questionnaire was systematically gone through with the purpose of clarifying the respondent's understanding of each question and potential difficulties in answering the question. These interviews are not part of the above described 11 interviews.

The questionnaire was subsequently corrected and completed with inspiration from the comments collected in the pilot study.

3.3.2 Composition of the questionnaire

The questionnaire is divided in five sections which contain questions about different subjects/information regarding iHospital. The five sections contain the following:

1. Background questions (gender, age, department, occupation etc.)

2. The use if iHospital ('How and how often do you use iHospital?')

3. Attitude towards iHospital (arrangement of different statements of which the respondent is to make up his/her mind about by means of the reply categories agree – neither/nor - disagree).

4. Streamlining in connection with the implementation of iHospital (respondents' subjective judgement of the streamlining aspect).

Every question is answered by means of closed reply categories. The complete questionnaire can be seen in appendix 7.

3.3.3 Population

The population of the questionnaire is, as mentioned above, every staff member at Horsens Regional Hospital who uses iHospital in their daily work. In this survey it was not necessary to select a sample of the population because it was practically possible to include the entire population in the survey. The population consists of a total of 411 individuals and includes staff members from:

- Service department   (7 individuals)

- Department of Gynaecology   (ward)   (59 individuals)

- Orthopaedic surgical ward   (ward)   (87 individuals)

- Organ surgical department   (ward)   (80 individuals)

- Surgical ward   (47 individuals)

- Anaesthetics department   (62 individuals)

- Intensive care unit   (51 individuals)

- Central sterilisation department   (18 individuals)

3.3.4 Distribution and collection of questionnaires

The questionnaires were handed out personally to each staff member at Horsens Regional Hospital. The staff members were encouraged to spend their working hours to fill out the questionnaire. Each staff member received an envelope with a covering letter, a questionnaire and an envelope made anonymous to use when returning the questionnaire. These envelopes were collected at Horsens Regional Hospital and returned to HTA and Health Services Research for further processing.

Management in the departments involved were asked twice in the process to remind their staff to remember to fill out the questionnaires. At the final reminder, extra questionnaires were handed out in case of some of the respondents had misplaced their first questionnaire. It was not possible to remind each individual staff member personally, because the questionnaires can only be identified on department level. This also gives rise to a small risk that the same staff member may have filled out the questionnaire twice. However, it is considered unlikely that this could have happened on a scale that will affect the validity of the survey.

3.3.5 Response rate

As mentioned above, the population for this questionnaireconsists of all staff members at Horsens Regional Hospital who use iHospital in their daily work. That is, the population is comprised of 411 individuals who each received a questionnaire. 236 individuals returned a filled out questionnaire which results in a response rate of 57.4 % (see figure 4.1).

Figure 3.1 Response rate at the questionnaireat Horsens Regional Hospital

| Questionnaire given to **411** persons. | → | Completed questionnaires from **236** persons. | → | Evaluation received from **57.4** % of staff |

3.4 Time recordings in the operating rooms

In connection with this HTA study two time recordings were made in the operating rooms in the central surgical ward at Horsens Regional Hospital. The objective of these recordings is to detect potential gains by the use of iHospital in correlation with being able to complete the daily surgical programme more effectively.

In the central surgical ward atHorsens Regional Hospital there are nine operating rooms divided between four specialties:

- Organ surgery
- Urology
- Gynaecology
- Orthopaedics surgery

Detailed time recordings at the nine operating rooms were collected before and after the implementation of iHospital. The first recordings were made in the period from 3rd September to 14th September 2007 and the last recordings from 27th October to 7th November 2008. (Please note that the recordings were made with approximately one year intervals, which allows takinginto account a potential seasonal variation). In the first period iHospital was implemented in three operating rooms (a gynaecological/obstetrics room and two orthopaedics rooms) and in the second period the technology was implemented in all nine rooms. Statistically, this provides the opportunity to investigate the effect of iHospital while simultaneously correcting any time trends. On every working day in the recording period the operating rooms were assigned daily registration schemas[6], where every surgery on the room in question was to be recorded in correlation with the following parameters:

- The operating room's number and opening hour (start and finishing time)

- The patient's civil registration number

- Surgery type

- Is the surgery planned or acute?

- Is the surgery going to be cancelled?

- At what time is anaesthesia initiated for each patient?

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[6] The registration schema can be seen in appendix 8

- At what time is the surgery initiated for each patient?

- At what time is the surgery concluded for each patient?

- At what time is anaesthesia concluded for each patient?

Special circumstances for registration period 1:

- ♦ iHospital was used in three operation rooms and not in the remaining sixoperation rooms.

- ♦ Therefore, personnel had to consider both printed operation plans and the interactive screens in the three operation rooms where iHospital was used.

Special circumstances for registration period 2:

- ♦ iHospital was used in all nine operation rooms.

- ♦ iHosptial is closely integrated with the hospital's scheduling system (Book-Plan).

- ♦ The evening operation room for acute patients had been put out of service due to financial savings $\Rightarrow$ more acute patients to be handled through daytime.

- ♦ One room was reserved for anasthesia where anasthesia procedure was done before the patient was moved to the operation room.A shortage of anasthesia nurses during the period meant that the anasthesia procedure took more time.

3.5 Register study

To illustrate the overall financial development at Horsens Regional Hospital a register based study of financial key figures of the period 2005-2008 was made. The main objective of the study was to examine how productivity in the hospital's stationary surgical ward developed at the period of iHospital compared to previous years.

Table 3.2 below shows an overview of the data used, the data sources and a definition of the data extracts. It was only possible to get data from a four-year period from 2005 to 2008.

Table 3.2 Overview of data in the register study of the development in productivity atHorsens Regional Hospital

Variable	Sources	data extracts
DRG-value	eSundhed[7]	Extracts demarcated by period and type of surgery (V/P) calculated on the basis of the department's patient discharges.
Salary	Silkeborg Løn[8]	Extracts demarcated by period, department and type of expenditure.
Other operations	The financial system ØS2000 plus budget follow-up overview from 2005	Extracts demarcated by period, department and type of expenditure.

The DRG value is extracted in eSundhed on the basis of type "Art V/P" ('Vital surgery/Primary surgery'), by which it is ensured that the calculated data contain a surgical procedure. In this way, every surgery is to be registered with an "Art V/P".

In the register study, the DRG-value is defined as department discharges to ensure that the DRG-value of every surgical procedure is included in the calculation. The DRG-value of hospitalised patients can normally be calculated in two ways, either as the value of department discharges or as the value of hospital discharges. A hospital discharge may consist of several departmental discharges, as long as the patient in question has been relocated between several departments in the hospital before the final hospital discharge. In the event of a discharge from one department followed by an admission to another department in the same hospital on the same day, it is a case of another department discharge. The DRG settlement between region and hospital, or between regions, is based on hospital discharges, and the hospital discharge is settled as the largest of the department discharges' DRG value. In this way, the number of department discharges will always be bigger than the number of hospital discharges. In this case, a DRG value is estimated from each department discharge in order to include the value of all surgical activities.

The DRG values occur in the period of which a patient is discharged from the hospital.

For instance, if a patient is hospitalised and operated on 25th January 2008 and discharged on 4th February 2008, the DRG value will be assessed in February.

Expenditures for salaries cover every salary expenditure for staff members in the surgical, care and anaesthetics departments (i.e. salary for nurses, service assistants/staff members, social and health care assistants, nursing assistants, secretaries etc.). The salaries of physicians and department management are not included in the statement as the only groups.

The reason for not including expenditures on physicians is that the surgeon's salaries are not entered into the accounts of the operating section but in an independent section within the respec-

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[7] "eSundhed" is an information system which facilitates communication about financing, accounting and the underlying hospital activities based on the DRG-system.

[8] "Silkeborg Løn" is the region's wage- and HR-system.

tive clinical departments. This means that it will only be possible to calculate the collected salary expenditures for the surgeons. It is not possible to take into account how the surgeons have spent their time. Surgeons do many other things in addition to operating patients (for instance, work in outpatient clinics, doing ward rounds, admistrative work etc.), and moreover, during the research period a changing number of research physicians who have not performed surgery have beenemployed. To avoid using an arbitrary basis of distribution in order to estimate the use of the surgeon's time consumption on operations, it has been decided to disregard the surgeon aspect.

The expenditures for other operations cover the material and activities costs, medicine, implants, clinical analyses and other medical items. Thus, not included are acquisitions, inventory, apparatus (e.g. IT and furniture) and also the operation and maintenance of apparatus, inventory and rooms.

Between 2005/2006 and 2007/2008 there was a variation in the categorisation of expenditures because a new chart of accounts was implemented in connection with the forming of the regions as of 1st January 2007. This resulted in a change in the way whereupon budget headings and items of expenditures were categorised and registered overall. It is estimated, however, to have had some influence on the comparability of the estimated expenditures between the periods of time.

The expenditures to other operations appear in the period of which the goods related (medicine, medical items etc.) were delivered to the departments. In other words, other operations are charged in the departments of the time when the goods have been delivered. This does not necessarily imply, however, that the goods have been spent in the period in question. Big purchases (for instance, when approaching the turn of a year) may imply technically seasonal variations in the registration of expenditures and a time lag between the accounting registration of expenditures to salaries and other operations, and also the DRG value of a given activity in the hospital.

The method for analysis of the collected data is elaborated on in chapter five on economy.

3.6 Assessment of literature

Two systematical literature searches and subsequently a systematical literature assessment have been carried out as the basis of this HTA report. The literature searches are carried out following an already put up search strategy. It should, however, be mentioned that the databases used are organised differently and that the subject headings are also indexed differently. This means that each database requires its own tailored edition of the overall search strategy.

The literature search was divided into two searches. One of the searches was organised in a way of which a general search on 'pervasive technologies' and the health care sector was performed. The search profile contained search criteria such as 'pervasive healthcare', 'pervasive computing', 'ubiquitous computing', 'health care', 'health care setting' and 'hospital based*'. The search protocol is kept as documentation by HTA and Health Services Research and may be requisitioned.

Searches in the clinical databases PubMed, EMBASE, Cochrane and SvedMed+ were carried out. Additionally, searches in the international HTA database, the nursing professional database Cinahl and the IT professional database Computer and information systems were carried out.

Finally, searches in the more general databases bibliotek.dk[9] and NLM Gateway were carried out. Searches were carried out between1998 and October 2008. Literature in English, Danish, Swedish and Norwegian was included.

In addition, a search with focus on pervasive technologies and productivity was carried out. This search was organised in a way that allowed the subject headings chosen to be connected to a subheading on economy as far as possible.. This strategy was selected because an initial search within the area of economy and pervasive technologies did not deliver any useful references. Enough literature had notbeen published within this field. For that reason, the search was widened to include information technology within the broad field of health care and economy. This is a field in which much literature is published. Consequently, the search was narrowed by linking the mentioned subheading to the selected subject headings. The search profile contains search criteria such as 'information systems', 'computerized Medical Records Systems', 'Hospital Information Systems', Hospital Communication Systems', 'Medical Informatics', 'productivity', 'productiveness', 'efficiency' and 'effectiveness'. The search protocol is kept as documentation by HTA and Health Services Research and may be requisitioned.

Searches in the clinical databases PubMed, EMBASE, Cochrane and SvedMed+ were carried out. In addition, searches in the international HTA database and the two financial databases EconLit and NHS EED were carried out. Searches were carried out between1998 and October 2009. Literature in English, Danish, Swedish and Norwegian was included.

Because the field of pervasive technologies for use within the health care sector is a relatively new field of research, there is not yet much literature to be found. In addition, the majority of the literature that exists within this field deals with technologies that are designed to engage directly in the treatment of patients. Much of the published literature deals with technologies that can assist the treatment of patients outside of the hospital. This means that literature dealing with pervasive technologies which support the health professional's working procedures in the hospital is not particularly widespread. Additionally, no comprehensive comparative studies of systems like these have been made, and not many studies concerning productivity could be identified either.

This means that a distinct systematical evaluation of the literature found does not make sense to carry out. A final systematic review of the literature found has not been possible, neither in the technological, the organisational, nor the financial area. The literature found has been examined by relevant professionals and used as background and reference in this report.

Besides the literature that has appeared through the systematical literature searches, literature has also been collected from relevant professionals within the area through reference lists from the literature found, and by searching relevant profession environments within the field of study.

3.7 The theoretical underlying basis of the study

In this HTA study several different data collection methods and different theoretical approaches have been used to support the various analyses and the understanding of the collected data as basis of the framework within which the collected data is analysed. These theoretical approaches are described in this paragraph.

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[9] The Danish National Library.

3.7.1 Sociotechnical approach

The understanding of the organisation and technology behind the analyses of this HTA study can overall be characterised as a sociotechnical approach. The approach especially addresses individuals who design IT systems, but the fundamental understanding of the interplay between organisation and technology expressed in the theory makes sense in an assessment and evaluation phase.

In his article, "Patient care information systems and health care work: a sociotechnical approach", Marc Berg points out the significance of involving sociotechnical knowledge about the design and use of information technologies within the health care sector when IT systems are designed for the health care sector. Berg describes the development of the sociotechnical approach, which took its starting point approximately 20 years ago, when the term 'sociotechnical systems design' was used to indicate a design approach which emphasised the significance of job satisfaction, the needs of staff members and skills development. This approach focused on people and their work relations opposite to the technology centralised approach, which dominated the system development at the time [21].

Berg believes that the user-oriented perspective of the sociotechnical approach encourages a thorough understanding of the working procedures that the IT system is to support. The perspective should therefore be the basis for the design and implementation of these systems. In the same article, Berg emphasizes that the sociotechnical approach is working procedures conceptualised as networks of people, instruments, organisational routines, documents and so on. These instruments, documents and machines are constitutive elements of an organisation's working procedures. If one is to remove even a simple object, e.g. an order form from an ordinary emergency room, this working procedure will no longer be able to proceed in the same complex and smooth manner. The introduction to new elements in a network, such as a new IT system, will often resonate through the entire organisation because of the tight connection between the elements in the network [21]. The reliance on the tight connection between the elements in a network, which is a fundamental assumption in the sociotechnical approach, leads to technology and organisation as not being perceived as belonging to different domains or operating on the basis of different sets of logic [7;21;25-28].

Berg concludes by stating that from at sociotechnical point of view the development of an IT application to the health sector will consequently never be a question of merely installing and using a new technology. The close connection between the technological and the human/organisational elements in the network implies that any design and implementation effort necessarily leads to changes in these networks [21].

3.7.2 Theoretic organisational models - Mintzberg

Founded in the sociotechnical approach, the background of the analyses of this report is that technology and organisation are inextricably linked. In continuation hereof, the assumption is also that the introduction of a new technology can lead to changes in the organisation of work assignments, content of work assignments and organisational model. Simultaneously, the organisation of work assignments, content of work assignments and the organisational model can affect further development of the technology.

As the basis of an analysis of implementation of new IT systems, attempts will be made to identify the organisational form, workflow, and work assignments before and after the implementation of a new IT system. In the traditional organisation theory, three archetypes exist which describe different organisational models and their different ways of solving tasks. These are the

sequential conjoined organisational model, the parallel conjoined organisational model and the reciprocal conjoined organisational model.

Mintzberg's organisational design is often used. In this, an organisational structure is considered a collective name for how an organisation divides and coordinates its work assignments. The two central elements in the understanding of an organisation are thus the division and coordination of work assignments. One significant focal point for all three archetypes is which coordination mechanisms that are used to link together the different constituent elements in the organisation. In organisational theory, the work primarily revolves around four coordination mechanisms:

- Reciprocal adaptation

- Direct supervision

- Coordination of professional competence/skills, respectively

- Coordination of process and objective [29].

Organisations in thehealth care sector's are often described as professional bureaucracies characterised by staff members being grouped on the basis of professional competence, and where the tasks of the organisation is primarily coordinated based on a standardisation of the staff members' competence and skills. This is due to the complexity associated with the work performed by health professionals [29;30].

3.7.2.1 Three archetypes of organisational models

Below, a brief overview of the three archetypes of organisational models is illustrated. In the description of the archetypes, focus is particularly on the primary processes of the organisational model which lead to the desired objective of the organisation. In an organisation, many processes happen simultaneously, but the focus of the description of the archetypes is the primary processes in the organisational model. As stated, this section deals with pure archetypes, which will in practice most likely appear in a mixed form. The models below illustrate the subsidiary actions (e.g. preparation of operating room, anaesthesia, surgical procedures etc.), which are to be executed in correlation with a specific course of surgery. The arrows between them show the connections that the collaboration prescribes, and the circles illustrate the result of the actions made, in other words, the patient having gone through surgery. Each archetype will be presented by a figure and a table in which the characteristics of the archetype are described.

Archetype 1 – The sequential conjoined organisation model
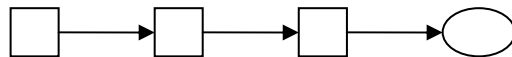
Table 3.3 Characteristics of the sequential conjoined organisational model

Type of depend-ency	Action sequence	Coordination mechanism	Nature of the collaboration	Professional compe-tence/professional demarca-tions
Sequential	Actions occur in a fixed sequence. One action has influence on the next. Ones output is the input of the next.	Standardisation of the process (content and schedule). Standardisation of professional compe-tence/skills. Clear agreements concerning the tran-sition from one ac-tion to the next.	Formalised co-orporation supplemented with personal contact.	The profes-sional demar-cations are well-defined and demar-cated.

Archetype 2 – The parallel conjoined organisation model
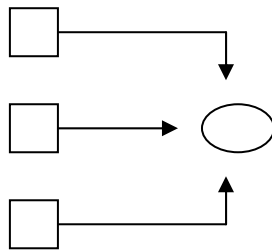
Table 3.4 Characteristics of the parallel conjoined organisational model

Type of depend-ency	Action sequence	Coordination mechanism	Nature of the collaboration	Professional compe-tence/professional demarca-tions
Parallel (pooled)	Subsidiary treatments do not require to be exe-cuted in a particular se-quence. Every subsidiary treatment must be con-cluded in order to obtain the desired result. Every-body work towards the same objective.	Standardisation of objectives. Standardisation of professional compe-tence/skills.	Formal coop-eration.	The profes-sional demar-cations are well-defined and demar-cated.

Archetype 3 – The reciprocal conjoined organisation model

Table 3.5 Characteristics of the reciprocal conjoined organisational model

Type of dependency	Action sequence	Coordination mechanism	Nature of the collaboration	Professional competence/professional demarcations
Mutual (reciprocal)	What happens in one action has influence on what can be done in the following action. The actons are mutually dependent.	Mutual dependency in the relation between professionals. Reciprocal adaptation, Standardisation of professional competence/skills.	Require much direct communication. Can be difficult to manage in practice, especially in big organisations and across departments.	As a rule, the professional demarcations are demarcated, but the reciprocal dependency to other actions requires great knowledge in other professionals' specialties.

In the above-mentioned archetypes, cooperation is coordinated by means of standardisation of different elements within the course of events related to how integrated the cooperation appears. In the sequential conjoined organisational model, the process is standardised as a coordination mechanism, in the parallel conjoined is the objective standardise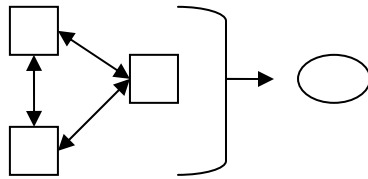d as a coordination mechanism, and in the reciprocal conjoined organisational model it is the mutual dependency in the relation between professionals who coordinate the course of events.

A supplemental way to coordinate complex courses of events is to use a coordinator function. Mintzberg points out that it can be desirable to appoint a coordinator. The coordinator's function is not to exercise direct control over the course, but to a greater extent to be a negotiating link between the different professionals included in the collaboration. The possibility to supplement the inherent organising coordination mechanism with a designated coordinator function is especially emphasised as an advantage in cases of the collaboration types which support a highly integrated cooperation, such as the sequential conjoined organisational model [29].

3.7.3   Theoretical understanding of awareness – common consciousness

As mentioned earlier in the report and in the description of the sequential conjoined organisational model, it requires effective cooperation, coordination and communication if one wishes to ensure a smooth workflow in a surgical ward. Much time and energy can be spent on collecting information on where the different staff members are located, what they are doing, collecting information on changes in the planned schedule and to ensure that the right staff are present in the operating room at the right time together with the right patient [31].

In connection with the research behind and development of iHospital, many hours of observational studies in hospitals were conducted with special attention to the surgical ward. One of the central concepts of these observations was awareness or acommon consciousness. This common consciousness can be perceived as a central precondition of coordination of complex organisations. As a result of these observations, a conclusion was reached that the common types of consciousness can be divided into different types of supplemental awareness. When observing the coordination in a hospital environment, the three most important types of awareness are 'social consciousness', 'spatial consciousness' and 'temporal consciousness'. Below, the three types of consciousness are described in brief:

Social consciousness: When an individual is aware of another individual. This may include knowledge about where the other individual is located, what the individual is doing, self-reported status or the like. This type of consciousness is not personal ('I know what my colleague is doing'), but rather publicly accessible between all collaborating colleagues ('we all know what everyone is doing'). Social consciousness is a general consciousness among colleagues about what one another is doing and where everyone is [4].

Spatial consciousness: When an individual maintains awareness about at specific location, for instance supervise what is going on specifically in this location. In this way, the spatial consciousness helps to understand the activities which take place in a specific room. In other words, the consciousness is not only restricted to individuals (social consciousness), but to places as well (spatial consciousness). To have a spatial consciousness in the surgical ward will include that staff members know what surgery is being performed, the activity level, status of the surgery, what staff members are present in the room including the patient and any signs of contingent situations, such as delays and unexpected complications during the surgery [4].

Temporal consciousness: Temporal consciousness deals with the maintenance of awareness regarding the past, present and future activities significant for the individual. Temporal consciousness is crucial for temporal coordination. It helps staff members adjust their own actions in correlation with a series of past activities, ongoing activities and expected future activities. The surgical programme for each operating room is an important part of the temporal coordination in a surgical ward and thus also in correlation with the temporal consciousness [4].

The basic hypothesis is that a combined overview of people, locations and time can assist health professionals in becoming more efficient in their coordinating work, including the issue of handling contingent and critical situations [4].

Seen in this light, the drawback of using whiteboards and telephones as means of communication is that the information provided is only visible/audible in one place. In order to obtain the information written on a whiteboard, staff members often have to move physically, because these whiteboards are often placed in one central location in the surgical ward. Telephone conversations usually involve only two individuals, and the information and communication which takes place during the course of the conversation therefore remains between these two individuals, unless they actively do something to pass on this communication. Therefore this type of communication can not be said to be particularly productive for the common consciousness.

Finally, we wish to quote on of the respondents who attempt to provide an overall description of the concept of awareness:

> *Awareness is the subconscious control function inherent in all of us, for instance, when we ride a bicycle. We then pay attention to the following: Where are the others? What is my current task? It is not something you consider, because you would then fall off the bi-*

cycle. It is something that functions within some of the fundamental parts of the brain. That you unconsciously keep yourself informed and have a feeling of safety.

3.7.4 Summary related to the theoretical background

The three theoretical approaches described above form the basis of the analyses of the collected data and the understanding of these. However, the three theories have slightly different backgrounds. Mintzberg's theory of different organisational models has a very rational and normative starting point. According to Mintzberg, the point of origin of organisational design is to design the organisation in the best possible way in order to achieve the organisational objectives and visions by the most rational and efficient means. Subsequently, the objective is to get all individuals and groups/units to work for the achievement of these goals and visions [29].

The sociotechnical approach and the theory of common consciousness (awareness) do not have the similar normative basis as Mintzberg's theory of organisational models. To a greater extent, they originate from a tradition in which focus is on the interaction between people, technology and organisation. Organisations are not necessarily perceived as working towards an incorporated objective/vision, but as something which develops in interaction with the surroundings and the different parts of the organisation. The rationality and efficiency are not always determiners of the development of an organisation.

The combination of these two different theoretical foundations happens from the logic that the sociotechnical approach establishes the significance of studying orgasational aspects by the implementation of new IT systems. It emphasises that technology and organisation cannot be perceived as separate parameters. As a result, Mintzberg's theory on organisational models is involved for the purpose of researching the internal logic of different organisational variations, knowing full well that other factors than rationality and efficiency might be at stake within different organisations.

4 Organisation

4.1 Introduction

As mentioned earlier, the Danish Board of Technologypublished a report in 2006 dealing with health benefits using IT with focus on pervasive healthcare. In the organisational analysis in the report from the Danish Board of Technology it is generally stated that the health sector is comprised of a great amount of parties who must collaborate in order to treat and nurse the patient. Furthermore, it is concluded that this working method requires knowledge sharing and collaboration, but in practice it often causes difficulties because of organisational barriers, lacking communication and imprecise data. The report points out that technologies within pervasive healthcare can help to solve some of these issues, but the possibilities which the technologies hold cannot be utilised without a number of organisational conditions being in place. The technology must partly be implemented in the organisation, in part the staff members must accept the technology and learn to use it, and partly a number of new tasks must be executed and coordinated as a result of the new system. This may turn out to be a great challenge [15].

Consequently, the organisation becomes an important element to consider to when you concern yourself with the implementation of new IT systems. According to the Danish Board of Technology, the implementation of pervasive healthcare in the health care sector contains roughly speaking four types of challenges: Technical, educational, psychological and organisational. The implementation process typically focuses on the first two, but according to the Danish Board of Technology, pervasive healthcare will not deliver positive results until the final two also are taken seriously [15]. In 2009, Brian Shackel wrote an overview article about human and computer interaction. It this article, he writes, 'successful system design is primarily an exercise in organisational change' [32].

On the basis of these considerations, it does not make sense to perceive technology and organisation as two separate and independent parts, and consequently organisational analysis becomes an important element in the implementation of new IT systems.

4.1.1 Organisational analysis in a HTA perspective

As pointed out in the HTA handbook published by the Danish National Board of Health in 2007, it is very difficult to put up a generic analysis model applicable to all organisations and to all issues within an organisational analysis. Consequently, organisational analyses must to a greater extent than both clinical/medical and economic analyses be adjusted to the individual case or issue. In addition, it is pointed out that the health care sector's organisations, including hospitals, are so big, complex and confusing that the 'catch-all' ambition is probably not realistic. This entails a great need to make explicit choices and demarcations in connection with the organisational analysis. In spite of these characteristic features of the organisational analysis, the HTA handbook points out that through such an analysis can create a qualified foundation in relation to technological choices and their consequences [28].

4.2 Objective

A way to demarcate the organisational analysis is to make the desired objectives the starting point of the analysis. The objectives which form the basis of the organisational analysis are primarily put up in the light of the original objectives to develop and implement iHospital. Knowledge about these objectives is primarily collected through interviews with the management of Horsens Regional Hospital and central individuals behind the development of iHospital. This

also means that the objectives put up can be an expression of a certain degree of post-rationalisation. Hence, the objective of the organisational analysis is to study the following:

- Has the implementation of iHospital has lead to changes in the organisational model in the central surgical ward?

- Has the implementation of iHospital provided staff members with a better overview of tasks and the daily surgical programme?

- Has the implementation of iHospital produced a changed communication and information flow?

- Has the implementation of iHospital contributed to an improved working environment?

Additionally, the analysis is centred further around the tasks, which has implications on the execution of the daily surgical programme in the central surgical ward atHorsens Regional Hospital. Several of the staff members who appear in the ensuing analyses also have tasks which are not directly related to execution of the daily surgical programme. Through data collection and the ensuing analyses, it has been attempted to focus on the tasks which relate to the execution of the daily surgical programme, because iHospital in its starting point is designed to support this.

To make the achievements of these objectives probable, two theoretical approaches and also empirical data collected at Horsens Regional Hospital are primarily employed. The theoretical focus is on the concept, awareness and Mintzberg's organisational theory on organisational models and the embedded coordination mechanisms implied in these models. For a detailed description of the theoretical foundation of the analyses in this HTA study, please readthe overall method section in which these theories are described.

The empirical data comes from interviews made with relevant areas of specialty at Horsens Regional Hospital. In addition, data collected by means of a questionnaire completed among all staff members in the Regional Hospital who use iHospital in the daily work, is analysed. For a thorough evaluation of the method behind the interview study and the questionnaire, please read the overall method section of this report. Furthermore, all results from the questionnaire can be consulted in appendix nine.

The actual organisational analysis is organised in various stages. The first part of the analysis describes the overall organisational model of the execution of the daily surgical programme at Horsens Regional Hospital. By the means of four case descriptions, the organisational model is analysed before and after the implementation of iHospital. Subsequently, the empirical organisational model is connected with Mintzberg's theory on archetypes of organisational models. Next step of the analysis examines if the implementation of iHospital supports the mechanisms that are in the theory described as central for the optimisation of the organisation in the execution of the daily surgical programme. This is examined by means of the concepts of mutual adjustment, awareness/common consciousness and communications. Overview of the daily tasks, patients, staff members, equipment, operating rooms etc. is a central element in this part of the analysis. The analysis in concluded with an assessment of iHospital's influence on the working environment at Horsens Regional Hospital.

4.3 Organisation of the central surgical ward

To clarify which organisational model the work surrounding the execution of the daily surgical programme is structured after, the figure below provides an overview of the organisation re-

garding the central surgical ward at Horsens Regional Hospital and the general workflow. The figure on the following page is an example of the entirely planned course where no acute patients, notifications of illnesses or other interrupting factors appear. The workflow illustrated in the figure constitutes one surgery for each of the nine operating rooms. This workflow repeats itself continuously as one surgery finishes and a new one begins.

Figure 4.1 – Organisation and workflow in the surgical ward – see the next page

Surgical department

| | | Anaesthesia start | Operation start | Operation ended | Anaesthesia ended | Cleaning/making room ready for next patient |

Operation room team:
Surgical nurse, Anaesthesia nurse

Surgeon

Personnel

Operation room

Sterile supply

Instruments

Patient wards

Patients

Sterile supply

Recovery

Patient wards

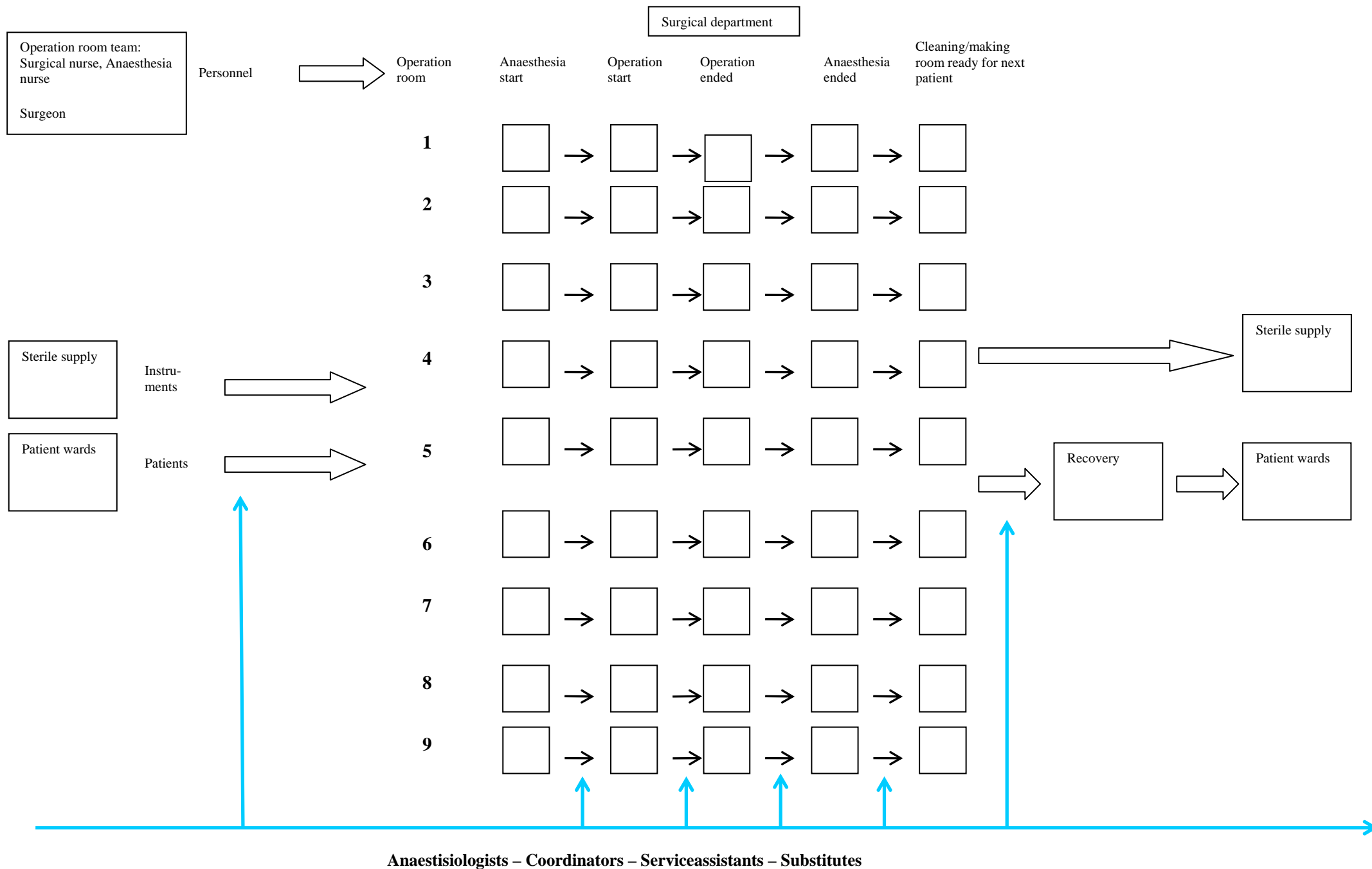**Anaestisiologists – Coordinators – Serviceassistants – Substitutes**

Figure 4.1 is an example of the entirely planned and sequential course (more on different organisational models in the paragraph about theoretical organisational models in the overall method section) without internal dependencies between the different surgeries, the different operating rooms, operating equipment and staff members in the different operating rooms. Thus, this is a simplified version of the reality of what a working day looks like in the central surgical ward at Horsens Regional Hospital. In the scheduling of the daily surgical programme, it is sometimes necessary to book a surgeon to perform surgeries on several different operating rooms during the day. Some surgical instruments only exist in few numbers, making it necessary to prepare the same equipment several times during the working day. For that reason, the different operating rooms have to coordinate the use of this equipment. Acute patients can move around to staff members in the surgical team and planned patients can be moved from one room to another. During a working day, there are therefore several possibilities of deviations from the stringent, sequential course which also creates vertical dependency in the sequential course. As illustrated in figure 4.1 by means of the vertical arrows (blue) and as described several times in the report, the execution of the daily surgical programme requires much coordination among staff members associated the central surgical ward and the collaborating departments.

At Horsens Regional Hospital there is a will to support this coordination by selecting two coordinators, whose tasks are to coordinate the daily surgical programme in the best possible manner. The coordinators are an anaesthesiologist and a surgical nurse, respectively. It is the task of these coordinators to make sure that the daily surgical programme is executed in the most appropriate manner, all resources taken into consideration (staff members, operating rooms, surgical equipment, time, patients, other activities in the hospital etc.).

4.4 Working procedures before and after the implementation of iHospital

Figure 4.1 illustrates the overall workflow in the central surgical ward and the collaborating departments at Horsens Regional Hospital. To shed more light on what actions the staff members actually perform as a result of this workflow, four patient pathways for a patient hospitalised for surgery are examined below. These case descriptions especially focus on what happens in the intermediate stage in the overall workflow, or put in another way, all the moments in figure 4.1 which are illustrated with a horizontal arrow. These case descriptions are based on material collected by means of observations, interviews and conversations with staff members at Horsens Regional Hospital. Together with figure 4.1, the case descriptions exist to clarify whether or not a change in the organisational model has occurred after the implementation of iHospital. In the period from the implementation of iHospital until now, changes in the working procedures which cannot directly be ascribed the implementation of iHospital have also happened. Specifically, the anaesthetics department has changed its procedures of the execution of anaesthesiological supervision. See the case descriptions below.

4.4.1 Case description of a patient pathway *before* the implementation of iHospital – without acute interruptions of the elective programme

- The patient shows up and is hospitalised in the ward.

- The ward plans on the basis of the printed paper-based programme they are handed from the early morning. These printed programmes are based on prints from the patient administrative system. If the staff of the ward presume that the timeline in the programme are not kept within the time frame, or that changes in the surgical programme have occurred, they check with the surgical ward to see if the programme proceeds according to plan. This contact happens by telephone.

- As previously agreed, the patient is set to fast either two or six hours before the expected time of surgery.

- Before the surgery, the patient has to go through an anaesthesiological supervision. If the patient is hospitalised in the ward, an anaesthesiologist supervises the patient the day before the scheduled surgery. If the patient shows up the same day as the surgery is to be performed, the staff members in the ward and anaesthetics department communicate about the most appropriate time for this supervision. This communication happens via telephone.

- The patient is to be brought to the operating room – but when is the staff ready to receive the patient? Staff members from the operating room notify the ward when they are ready to receive a new patient for surgery. In this way, the staff in the ward can only be at the forefront in preparation of patients if the surgical programme proceeds according to plan. This communication happens via telephone. If the ward needs to check if the programme proceeds according to plan, they contact the coordinator in the surgical ward via the telephone. The surgical programme is an estimate based on experience of the duration of each surgical procedure.

- The surgical ward sends for a service assistant to transport the patient to the ward. The service assistant is contacted by telephone.

- In the operating room, staff members have to check if the room is cleaned and prepared for the next surgery, if the surgical team is ready for the new surgery and if the right equipment is present in the operating room to complete the new surgery before the ward gets a green light. Potentially, this requires communication with the central sterilisation department, service department, surgical nurses, surgeons and anaesthetics department. This communication happens either physically by turning to the different individuals or by contacting them by telephone.

- When the patient enters the operating room, an anaesthesiologist is sent for if the procedure requires the use of a special kind of anaesthetic. Otherwise, the nurse anaesthetists, who are permanently associated to the surgical team in the operating room starts up the anaesthesia procedure. The surgical nurses, the coordinator and anaesthetics department are in ongoing physically contact or by phone in order to coordinate the time for anaesthesia.

- If all equipment is present in the operating room, and the patient is anaesthetised, the surgeon and the other staff members of the surgical team commence the surgery.

- In the coordinator central in the central surgical ward, the coordinators continuously have to keep an eye on the progression of the course of surgery in the operating rooms in order to be informed about of whether or not the daily surgical programme proceeds according to plan. Additionally, the coordinators must at all times have an overview of which operating rooms are the most appropriate for the replacing staff members to be inserted on (at lunch replacements, prolonged surgeries or rooms which could use a helping hand). The coordinator gets the necessary information either by calling the operating rooms, by walking to and looking into the operating rooms or by entering the rooms.

- During the course of surgery, the ward might need information about the surgery, if there are relatives present or hen the ward is to have the next patient prepared for surgery. This communication with the surgical ward takes place by telphone.

- A service assistant is sent for when the surgery is complete and the patient is ready to be brought to the recovery ward. This happens by telephone.

- The service assistant brings the patient to the recovery ward. Here, the staff members are not informed that they are about to receive a new patient. They only have the timeframes from the printed programme to relate to. For that reason, staff members are only informed when the nurse anaesthetists and the service assistant are standing in the recovery ward.

- When the patient is ready to be brought back to the ward, the recovery ward sends for a service assistant by telephone, and the patient is brought back to the surgical unit. The ward is not informed in advance that the patient is on the way. Therefore, staff members are only informed when the patient is physically back in the surgical unit.

4.4.2 Case description of a patient pathway _after_ the implementation of iHospital – without acute interruptions of the elective programme

- The patient shows up and is hospitalised in the ward.

- The ward checks on the monitors from iHospital if the daily surgical programme proceeds according to plan.

- As previously agreed, the patient is set to fast either two or six hours before the expected time of surgery.

- All elective patients who have been to preliminary examination at Horsens Regional Hospital have their anaesthesia chart made at this examination. At the day of surgery, anaesthesiological supervision will only be conducted if something particular is noted in this chart. If supervision is necessary, the ward and the anaesthetics department communicate about the appropriate time through iHospital. In the event of acute patients, an anaesthesiological supervision is performed at the day of surgery. The anaesthesiologist is mainly contacted through iHospital, but the telephone is also used in the event of more acute patients.

- The patient is to be brought to the operating room – but when is the staff ready to receive the patient? The ward continuously monitors the development of the daily surgical programme by means of monitors from iHospital. In that way, the patients are prepared for surgery at the right time. The surgical ward sends for the patient when they are ready to receive him/her. This communication happens through iHospital. That is, the ward uses iHospital to announce 'patient arrived' and 'patient ready' so this information is available to the surgical ward.

- The surgical ward sends for a service assistant to collect the patient in the ward. The service assistant is contacted by telephone.

- In the operating room, staff members have to check if the room is cleaned and prepared for the next surgery, if the surgical team is ready for the new surgery and if the right equipment is present in the operating room to complete the new surgery before the ward gets a green light. Potentially this requires communication with the central sterilisation department, service department, surgical nurses, surgeons and anaesthetics department. This communication mainly takes place through iHospital's chat function, by means of status notifications in iHospital and also by video transmissions from the operating rooms.

- When the patient enters the operating room, an anaesthesiologist is sent for if the procedure requires the use of a special kind of anaesthetic. Otherwise it is the nurse anaesthetists, who are permanently associated to the surgical team in the operating room who starts up the anaesthesia procedure. The surgical nurses, the coordinator and anaesthetics department have a continuous connection through iHospital concerning the anaesthesia. For instance, notes are written in iHospital concerning the anaesthesia progress.

- If all equipment is present and the patient is anaesthetised, the surgeon and the other staff members of the surgical team commence the surgery.

- In the coordinator central in the central surgical ward, the coordinators continuously have to keep an eye on the progression of the course of surgery in the operating rooms in order to be informed about whether or not the daily surgical programme proceeds according to plan. Additionally, the coordinators must at all times have an overview of which operating rooms are the most appropriate for the replacing staff members to be inserted on (at lunch replacements, prolonged surgeries or rooms which could use a helping hand). The coordinators get the necessary information by looking at the monitors from iHospital. Among other things, they look at status updates, video links from operating rooms and chat messages.

- During the course of surgery, the ward might need to get information about the surgery if relatives are present. This information is acquired by looking at the monitors from iHospital, primarily by the means of status updates and chat messages regarding the individual patient pathway.

- The recovery ward must keep track of when it can be expected to receive the patient after completed surgery. The recovery ward does not communicate directly with the surgical ward about this. Instead, they follow the execution of the daily surgical programme on the monitors from iHospital. The staff members in the recovery ward only contact the surgical ward if they can see that they will have trouble providing room for all patients from the surgical ward. This communication primarily takes place through the chat function in iHospital. The communication can both be between the operating room and recovery ward and between the coordinator central and recovery ward.

- A service assistant is sent for when the surgery is complete and the patient is ready to be brought to the recovery ward. This happens by the use of a telephone.

- The recovery ward is prepared for receiving the patient in question. It is informed by means of the monitors from iHospital.

- By means of the patient statuses 'recovery' and 'return to the department', which the recovery ward mark their patients with through iHospital, the ward can keep track on when they can expect to receive the patient again. The ward carries on status changes to 'patient discharged'.

4.4.3 Case description of a patient pathway *before* the implementation of iHospital – with an acute surgery.

- The planned patient shows up and is hospitalised in the ward.

- The ward plan on the basis of the printed paper-based programme they are handed from the early morning. These printed programmes are based on prints from the patient administrative system. If there is a presumption that the timeline in the programme are not kept within the time frame, or that changes in the surgical programme have occurred, they check with the surgical ward to see if the surgical programme proceeds according to plan. This contact happens by telephone.

- As previously agreed, the patient is set to fast either two or six hours before the expected time of surgery.

- Before the surgery, the patient has to go through an anaesthesiological supervision. If the patient is hospitalised in the ward, an anaesthesiologist supervises the patient the day before the scheduled surgery. If the patient shows up the same day as the surgery is to be performed, the staff members in the ward and anaesthetics department communicate about the most appropriate time for this supervision. This communication happens via telephone.

- The surgery ward is notified by telephone that an acute surgery must take place. This may for instance concern a femoral bone fracture. The surgical ward staff begins locating staff members and an operating room in preparation for the execution of the surgery. This coordination happens either with the coordinator physically turning to the relevant staff members or by telephone. Consequently this can only be communicated to a limited number of individuals at a time. The communication occurs between the coordinator central, central sterilisation department, ward, recovery ward, service department, surgeons, operating technicians, nurses, anaesthesiologists, service assistants etc.

- The acute surgery is started, moving the planned daily surgical programme, either because the acute surgery is performed in one of the planned operating rooms, or because staff members who were supposed to attend one of the planned surgeries are now occupied elsewhere.

- When the acute surgery is planned, the subsequent consequences of this change are to be communicated to the rest of the organisation. This communication primarily occurs by telephone. Consequently it can only be communicated to a limited number of individuals at a time. The communication occurs between the coordinator central, central sterilisation department, ward, recovery ward and service department.

- When the information reaches the ward, the originally planned patient might already be ready for surgery. The surgery of this patient is either postponed till later in the day or cancelled.

- The remaining of this patient pathway will subsequently be identical with the course described above in the case description of a patient pathway before the implementation of iHospital – without unexpected events.

4.4.4 Case description of a patient pathway *after* the implementation of iHospital – with an acute surgery.

- The planned patient shows up and is hospitalised in the ward.

- On monitors from iHospital, the ward checks if the daily surgical programme proceeds according to plan.

- As previously agreed, the patient is set to fast either two or six hours before the expected time of surgery.

- In the surgical ward, notifications on the monitors from iHospital inform that an acute surgery of a fractured femoral bone is to be put on the surgical programme. The surgical ward staff begins locating staff members, an operating room and surgical equipment to perform this surgery. This coordination happens by means of many channels. The coordinator can use the chat function from iHospital, physically approach the relevant individuals or the telephone. The communication occurs between the coordinator central, central sterilisation department, ward, recovery ward and service department.

- Simultaneous while the planning of the acute surgery falls into place, the changes are implemented in iHospital. These changes immediately appear in the central sterilisation department, the ward, the recovery ward and in every medical conference room. The central sterilisation department can prepare the necessary equipment, perhaps the ward can postpone the fast of the following patient and the recovery ward can prepare the reception of the acute patient.

- The acute surgery is started and, thereby, moving the planned daily surgical programme, either because the acute surgery is performed in one of the planned operating rooms, or because staff members who were supposed to attend one of the planned surgeries, are now occupied elsewhere. The implications of these changes for the rest of the daily surgical programme can directly be read on the iHospital monitors by all staff members simultaneously, both in the central sterilisation department, in the recovery ward, the ward and the operating rooms.

- The remaining of this patient pathway will subsequently be identical with the course described above in the case description of a patient pathway after the implementation of iHospital – with unexpected events.

4.5 Organisational model of Horsens Regional Hospital – before and after implementation of iHospital

In figure 4.1, which illustrates the organisation and the general workflow in the central surgical ward and the collaborating departments at Horsens Regional Hospital, it can be seen that this organisation broadly corresponds to the archetype one in Mintzberg's organisational theory – the sequentially conjoined organisational model, where standardisation of the process and standardisation of professional competency are supplemented with a coordinator function. The activities that take place in each operating room represent a sequential course. In that case, the task of the coordinator is to have an overview of all these nine courses simultaneously.

Mintzberg characterises the sequentially conjoined organisational model in the following way:

> *In the sequentially conjoined organisational model, actions happen in an arranged procedure, where one action has influence on the following. It can be a complex form of cooperation, because one error can spread to the entire course. In order to manage the complex procedure, the process is standardised, both in correlation with the professional competency and the skills possessed by each field of specialty, and in correlation with the content of the course of actions. The transition from one action to the next is decisive to*

the process of the entire cource of action, which necessitates a tight communication and mutual adjustment between the individual constituent parts [29]. (For further evaluation of Mintzberg's organisational models see the overall method section).

After a close reading of the four case descriptions above, nothing suggests that the actual organisational model has changed in the central surgical ward at Horsens Regional Hospital after the implementation of iHospital. The general organisational model can still be characterised as sequential. Some working procedures/tasks, particularly centred on communication and information, have changed their content and character according to the sociotechnical approach and others have become superfluous after the implementation of iHospital. For instance, many telephone calls have become unnecessary after the staff members have begun using iHospital. When changes in the daily surgical programme are made, these canbe communicated to all relevant staff members in a department on the monitors from iHospital. Operating rooms and wards no longer need particularly high levels of telephone contact because the staff members in the surgical unit can watch the development of the daily surgical programme on the monitors from iHospital and thereby prepare the patients for surgery at the right time without being in contact with the operating rooms.

However, the general sequential organisational model has not changed. Consequently, the interesting question is whether or not the implementation of iHospital supports some of the mechanisms Mintzberg describes as being central of an optimal utilisation of the sequentially conjoined organisational model?

If one looks at Mintzberg's description of the sequentially conjoined organisational model, the latter part of the quotation above should, in this context, be noticed. Here it is emphasised that the transition from one action the next is imperative to the process of the entire course of action in the sequentially conjoined organisational model. Simultaneously, Minzberg emphasises that this characteristic of the sequentially conjoined organisational model necessitates a tight communication and mutual adjustment between the individual constituent parts. The mutual adjustment becomes significant, especially when working in an organisation where the tasks performed are highly dependent on one another. In such organisations, it is not sufficient to standardise the content of the different tasks that are to be executed.

4.6 Mutual adjustment, common consciousness, communication and iHospital

Cf. the paragraph above, Mintzberg emphasises that communication and mutual adjustment are important mechanisms in the sequentially conjoined organisational model in the attempt to create the optimal workflow. In order to obtain this mutual adjustment, it can be argued that the staff members need a high level of awareness or common consciousness concerning what their colleagues do during the working day (for a detailed description of the concepts awareness and common consciousness, see the overall method section). This common consciousness is gradually increasing concurrently with the amount of information available to staff members. The more common and relevant information staff members share, the greater the common consciousness will be. As emphasised by Fogarty et al., it is a precondition that the relevant and necessary information is presented in a way that enable staff members to quickly form an overview. Too much information can create confusion and cause a loss of overview [33]. Common or shared information and easy and fast overview of this information consequently become central parameters in the attempt to optimise workflow in the sequentially conjoined organisational model.

In the paragraphs on organisational models and awareness/common consciousness, factors which have influence for the optimisation of workflow in the sequentially conjoined organisational model are described from a theoretical perspective. This paragraph is followed by an assessment and analysis of the collected data seen in this light. Focus will be on whether or not the collected data support the presence of a common consciousness among staff members at Horsens Regional Hospital and an improved communications flow among these staff members. Emphasis will primarily be on data collected through interviews and questionnaires[10].

If one studies the structure of the questionnaire, the results can be interpreted on three levels according to the concepts of 'mutual adjustment' and 'awareness/common consciousness'.

1. Means/methods for staff members to increase the degree of the common consciousness (the use of iHospital).

2. Are preconditions for the common consciousness present? (overview and easy access to information)

3. The consequences of the possible increased consciousness (easier to manage changes, easier to coordinate cooperation etc.).

A precondition for iHospital participating in increasing the common consciousness among staff members at Horsens Regional Hospital is for the system's functions, which support such a common consciousness, to be used in the daily work. The use of iHospital can be divided into passive and active use. Passive use covers keeping yourself informed by means of the monitors from iHospital. It may both include looking at the surgical programme, looking at the video images from the nine operating rooms and informing oneself about which staff members one is to collaborate with during the day. In contrast to this, active use involves a direct action executed via iHospital. This may concern the introduction of changes in the daily surgical programme, the entering of a patient status, the updating of a status of an operating room and chatting via iHospital. Both the passive and the active use of iHospital is a precondition for the system being able to support the mutual adjustment and cause an increased awareness.

4.6.1 Passive use of iHospital

As seen in appendix nine in which the results from the questionnaire are reviewed, the passive use of iHospital is highly spread among staff members at Horsens Regional Hospital. A large number of staff members use the monitors from iHospital several times a day in order to follow the daily surgical programme and to watch video images from the operating rooms. The quotations below clarify some of the information the staff members get from the passive use of iHospital.

> *'Then I use it (the monitor) for monitoring -, I use it to check data as well, what kind of patient and surgery is this? Then I look at the estimated timeframe of the surgery. And then I use it to follow the other operating rooms. What are the other rooms short of?'*

> *'Well, you use looking at the board a lot (the monitor) and looking at the status bar to see how far they are in the operating rooms and...'*

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[10] Appendix 9 is referred to for an overall assessment of the results of the questionnaire survey.

4.6.2 Active use of iHospital

As seen in appendix nine, the active use of iHospital is not as widely spread as the passive use. This, however, is not strange, since the actions prescribed by the active use of iHospital is to a high degree delegated to specific personnel groups (changing the daily surgical programme, enter patient status, update status). As it can be seen when the results are worked out on departmental level, the specific personnel groups primarily carry out the active actions of which they are instructed. What is special about these active actions is that they are a precondition for the system to contain the necessary information which provides meaning for the passive use of iHospital. This point is clarified by the quoted statement below from a nurse in the recovery ward:

> *'Of course, the difference is also that we have to make sure to make corrections about the patient. When they are in the surgical ward, we have to enter into the system that they now are in the recovery ward. And if we do not remember to do so, then you will not be able to benefit from it. And we must always keep in mind that the system is not better than the people who operates it manually.'*

Concerning the use of iHospital, which is a fundamental precondition for the system to be able to create an increased common consciousness, the aggregated results from interview and questionnaire show that a large number of staff members at Horsens Regional Hospital use iHospital in their daily work. It is natural that only a limited number of staff members perform some actions, but, on the other hand, the results of the questionnaire shows that the relevant personnel groups to a high degree perform the actions required in order for iHospital to work at its best for the other personnel groups. With relation to this, it should be mentioned that staff members from the surgical ward are in general positioned high in their use of iHospital, both the passive and the active use. This must be seen as a consequence of the system being in its starting point designed to assist the working procedures in a surgical ward.

4.6.3 Preconditions for common consciousness and mutual adjustment

What does it require to maintain a common consciousness and to facilitate a mutual adjustment with it? As mentioned above, a hypothesis about the right amount of relevant information can be made. The right amount of relevant information is shared by staff members and is presented in a way that facilitates a quick overview of this information. It will help to assist the increase of the common consciousness and, by this, facilitate the mutual adjustment.

The staff members of Horsens Regional Hospital widely share information presented via iHospital. This is made probable by the widespread passive use of iHospital clarified in the paragraph above. But what about the overview?

As seen in appendix nine, one of the strongest results from the questionnaire is related to the question concerning 'a better overview of the daily work'. A big share of the consulted staff members have proclaimed being in agreement that the implementation of iHospital has resulted in a better overview of the daily work. At the same time, a big share of the staff has also declared that the implementation of iHospital has made it easier to access relevant information. These results remain relatively unchanged, even though the division is according to departments. However, staff members from the surgical ward and staff members with coordinator roles declare themselves in agreement with the two statements to a greater extent than the rest of the staff members.

From these results, it looks like the use of iHospital can help creating the preconditions for an increased common consciousness and thus a larger degree of mutual adjustment. The conducted interviews support the strong experience of an improved overview of the daily work. On the whole, every interviewed staff member from Horsens Regional Hospital expresses through the interviews that a better overview is one of the greatest benefits from the use of iHospital. Consulted in this way about the greatest benefits by using iHospital, one of the interviewed surgeons responds the following:

> *'Oh, there are many benefits. Overview when you stand by the I-board* (the monitors). *Also that you can look at the I-board in other places in the building. For instance in our conference rooms, although we only have a small monitor there.. And in the ward.'*

A staff member form the central sterilisation department describes in the interview what working there was like for herbefore iHospital, when she used a paper-based programme of the daily surgeries. She says:

> *'We could not see if the sequence in the rooms was changed, and neither could we see if acute patients were added. So we did not always know when acute patients came. Now, we are in complete control of this.'*

In an interview, a nurse expresses that she believes iHospital is the 'future'. When she is asked why this is her opinion, she replies:

> *'It is because I believe it provides a great overview of what is happening all around. For that reason, I believe it is the future. Because you feel well informed about what is going on and what is going to happen during the day.'*

4.6.4   The consequences of increased common consciousness

As described above, the results from the interview and questionnaire suggest that the use of iHospital has contributed to an increase in the common consciousness among staff members at Horsens Regional Hospital in the shape of better overview of the daily work and easier access to relevant information. If this is the case, it must be expected that the presence of this common consciousness can be read in some of the data collected by means of interview and questionnaire.

If one only turns to the results form the questionnaire, the focus is on the questions concerning changes in communication processes. If iHospital by means of a better overview and easier access to information has contributed to increasing the common consciousness among staff members , there should be a tendency in these questions for the staff members to declare in agreement that the implementation of iHospital has made it easier to get in touch with relevant personnel, to coordinate cooperation, manage changes, to communicate with relevant personnel, and that the communication between the departments has become better.

As seen in appendix nine, more respondents agree than disagree that iHospital has had a positive effect on communication, coordination and the opportunity to get in touch with relevant personnel in the hospital. This tendency is especially clear for the surgery ward, the anaesthetics department and staff members with coordinator roles. The agreement among respondents is especially obvious when it comes to managing changes in the daily surgical programme. This result can be interpreted as a strong indicator that the increased common consciousness among staff members at Horsens Regional Hospital can also be translated to concrete actions. When

changes occur in the surgical programme, there really is a need for a better overview, communication and coordination (see the case descriptions above).

In the interviews conducted with staff members from Horsens Regional Hospital, everyone was asked to describe their working day before and after the implementation of iHospital. In these descriptions several examples support the results from the questionnaire in correlation with changes in the communication. This is especially in evidence for the interviewed nurses, whereas the surgeons to a less extent express changes in correlation with working procedures in connection with communication, coordination and the opportunity for contact. This difference lies, naturally, in continuation of the respective roles of nurses and surgeons. When the surgeon is in the operating room performing a surgery, he does not communicate and coordinate much else than in connection with the actual surgical procedure, whereas the nurses often have the connection to the other staff members, the other rooms and the other departments in order to get the entire surgical programme executed.

One of the interviewed coordinators explains the difference between communication by telephone and communication by chatting in the following way:

> *'Well. Before, we spent a lot of time on the telephone, and we were interrupted all the time when it rang. Now when the screen flashes you can see that there is a message you have to attend to. But it does not need to be here and now, that is. You can sort of do it yourself, when it is convenient in your work.'*

And she continues by telling about the amount of available information:

> *'Much more is being written, that is, the act of informing occurs much more through the chat, because it is so easy to just type a message. And then you can see it when it is convenient. If you have to phone, and you know that it will disturb the concerned individual, well, then I think: No, it can wait for a while. Now, more information is provided.'*

One of the interviewed coordinators tells about the procedure in connection with the changes in the daily surgical programme after the implementation of iHospital:

> *'Well, I can write a message to them that they should notice that there has been a change. But then they can see for themselves what has happened. That is, you do not have to write down all data on a note and deliver it because the data is on the monitor.'*

4.6.5   Communications flow

As mentioned in the presentation of Mintzberg's theory of different organisational models, the two central mechanisms for optimising the sequentially conjoined organisational model are tight communication and mutual adjustment. These two mechanisms ensure that the transitions in the sequential course happen without too many conflicts. Above it is made probable that the implementation of iHospital provides the opportunity for an increased degree of mutual adjustment through an increased common consciousness. Communications flow and increased common consciousness are to some respects two sides of the same coin. A good and smooth communications flow is essentially a precondition to create a certain degree of common consciousness. Consequently, the communications flow at Horsens Regional Hospital has also indirectly been clarified in the previous paragraphs. The central results from the questionnaire and the interviews will, however, be commented on briefly in this paragraph.

From the questionnaire, three questions have been selected to focus on in connection with the clarification of communications flow in the central surgical ward and the cooperating departments at Horsens Regional Hospital. These are:

- Has it become easier to get in contact with relevant staff members?

- Has it become easier to communicate with relevant staff members?

- Has the communication between the departments become better?

As seen in appendix nine, more people declare that they agree rather than disagree that iHospital has entailed that it has become easier to get in contact with relevant personnel, that it has become easier to communicate with relevant personnel and that communication between departments has become better. At the same time a relatively large share of the respondents reply neutrally to these questions. When the results are divided onto departments it is seen that especially the recovery ward and service department/other bring down the share of respondents who agree with the three statements. The respondents from the remaining departments are to a great extent in agreement that the implementation of iHospital has had a positive influence on the communication between the staff members and the departments.

The conducted interviews also support the feeling of an improved communications flow to a great extent among staff members at Horsens Regional Hospital. As expressed by several respondents, an improved communications flow in this context is also to be understood as some communications actions that staff members no longer need to perform, because the relevant information is visible to all staff members at the same time on the monitors from iHospital. This point emerges, among other things, when a nurse from the ward explains how she uses iHospital. She says:

> *'Mostly, I use iHospital to see when my patients are put down for surgery, and also what time they are approximately to get surgery. And to monitor in the event of changes happening, and to see if the colleagues from the surgical ward notify us that now we need to prepare this and this patient and report back and... well, that is mostly it.'*

This respondent clearly receives a lot of information through iHospital just by looking at the monitors. Sometimes she communicates actively with e.g. the surgical ward through the chat.

One of the interviewed surgeons relates that in his opinion, the greatest benefits of iHospital are better communication and planning. He says:

> *'Because this has something to do with communication. And it is obvious that it provides a better and more reliable communication. Also to a larger share than we had previously. That is, that the departments are able to follow the situation, among other things. I believe this is important.'*

Overall, it seems that after the implementation of iHospital, a large share of staff members experience that there is a better and more smooth communications flow in the central surgical ward and the collaborating departments at Horsens Regional Hospital.

4.6.6 Organisational model and common consciousness - recapitulation

Looking back on figure 4.1 of the overall workflow in the surgical ward at Horsens Regional Hospital and the subsequent case descriptions of patient pathways before and after the imple-

mentation of iHospital, it was concluded that the overall organisational model has not changed as a consequence of the implementation of iHospital. The overall organisational model that best describes the organisation of the execution of the daily surgical programme is the sequentially conjoined organisational model. According to Mintzberg, the two central coordination mechanisms in the sequentially conjoined organisational model are standardisation of the process (content and timetable) and standardisation of professional competency/skills, which are to a great extent in evidence when looking at the course of procedure and execution of a surgical programme. Furthermore, Mintzberg points out that the critical points in the sequentially conjoined course are the transitions from one action to the next. If these transitions are to proceed smoothly, they require tight communication and a great extent of mutual adjustment.

In the analyses above, the emphasis is on studying if preconditions for mutual adjustment and a smooth communications flow change by the use of iHospital. A review of the analyses show that a great share of the staff members at Horsens Regional Hospital experience that the preconditions for an increased mutual adjustment are present when using iHospital. In addition, a great share of the staff members in most of the departments agree that the use of iHospital leads to better communication that reaches the relevant staff members more easily than before.

It looks like the use of iHospital helps create the preconditions for a more smooth and effective execution of the daily surgical programme at Horsens Regional Hospital. This conclusion is drawn under the assumption that staff members act rationally in the execution of their daily work. In other words, it looks like the use of iHospital supports a more smooth execution of the sequentially conjoined surgical procedure.

Finally, it should be mentioned that naturally some staff members at Horsens Regional Hospital partly disagree with the conclusions drawn in the above analyses. Among others, one of the interviewed coordinators expresses him-/herself in the following way:

> *'It is a good tool to create an overview. To form an overview. (pause) But, I do not think you can argue that things have become noticeably easier.'*

This coordinator, however, represents a minority of the interviewed staff members and respondents from the questionnaires. Furthermore, one of the interviewed surgeons expresses a concern that the systems will get to control all actions in the hospital. He says:

> *'It is as if – well, sometimes you have a feeling that it is the systems that run things. For instance, you are not able to get anything done if you do not have a patient who is registered and imported in BookPlan and has been transferred to the hospital. Then nothing can be done. It is, you see -. It corresponds to people collapsing in the street with cardiac arrest, and then I say: If you cannot provide me with your civil registration number, well, then I cannot give you a heart massage. In that way, the system sometimes is a bit strange. That it is somehow the systems that run this instead of the people.'*

4.7 Working environment and iHospital

As mentioned earlier, one of the objectives of the organisational analysis is to clarify if the use of iHospital has had influence on the staff members' working environment. A great motivation behind the development and design of iHospital was to create a better working environment and a more attractive workplace for the staff members at Horsens Regional Hospital. Consequently, it is also significant to examine if this vision is fulfilled. To quote a management representative from Horsens Regional Hospital:

'One objective we had was a working environment and stress relieving product which could ease the work load involved in having the responsibility for the right meeting between the right treatment, the right practitioner, the right assistants and in the right room.'

This part of the analysis will primarily be based on the conducted interviews with staff members from Horsens Regional Hospital. Furthermore, two statements from the questionnaire often related to working environment will be addressed in the analysis. They concern interruptions in the daily work and an overview of the daily work.

Many interruptions during the working day and a lack of overview of the daily work are traditionally mentioned as being factors that can participate in creating an incriminating working environment for the individual staff member. As mentioned earlier, one of the strongest results from the questionnaire is the share of staff members who agree that the implementation of iHospital has resulted in a better overview of the daily work (For a presentation of results from the questionnaire consult appendix nine). There is not quite as strong an agreement among staff members concerning the positive effect of iHospital compared to the results on fewer interruptions in the daily work. Overall,equal amounts of staff members agree and remain neutral to this question. If the result concerning fewer interruptions is divided onto departments or divided according to staff members with or without a coordinator role, a large share of staff members in the surgical ward, central sterilisation department and staff members with coordinator roles agree that the implementation of iHospital has meant fewer interruptions in their daily work.

The results from the questionnaire indicate that many staff members at Horsens Regional Hospital believe that two significant factors for a good working environment have been improved with the implementation of iHospital. But is this connection supported in the conducted interviews?

Most of the interviewed staff members express that iHospital has affected their working environment in a positive direction. One staff member from the central sterilisation department expresses very clearly the attitude that iHospital has contributed to improving the working environment in her department. She says:

'We have got much more peace to perform our tasks in our department. And naturally, it affects the psychical working environment as well. We treat each other better. That is, in the past when we had these frustrations, I call it frustrations, from the surgical ward, when they were in these situations, then we let it affect us as well. That is, you take it out on the colleague closest to you, because then someone else gets to have it. It is not me (laughter). These problems we have gotten rid of.. We are treating each other much better because of this. Yes. Or, it is one of more factors at any rate.'

The chat function is mentioned by several respondents regarding the working environment theme. Among other things, one respondent from the ward says the following:

'When you are chatting, you do not sense the frustrations and the stress there might be in the department or in the surgical ward. Because when you chat together, then it is a hello, or good morning, or what ever you might write. It is a friendlier tone. You do not sense the unrest there might be.'

A coordinator in the surgical ward relates about the pleasure of working with tools that work. She says:

> *'Well, it is nice to have some toolsthat make procedures run more smoothly. It results in that -. Well, it results in a greater job satisfaction when you feel that things are working well.'*

Among the interviewed staff members there are at the same time representatives whoexpress the more neutral attitude in correlation with improvement of the working environment. Namely that iHospital in their opinion has not had that big an impact on their working environment.

Through the interviews, several respondents express that iHospital might have had a positive influence on the working environment, but the use of iHospital ought to be seen in connection with other initiatives regarding the working environment at Horsens Regional Hospital. In that connection, a nurse from the ward says the following:

> *'I think that it yet another good initiative that is being taken to make it a place where you like to be. That is, it is not only the iHospital which is doing this. But it is one of the reasons that the working day is relieved, and, as you say, you feel that you are noticed and things are done to make you better able to plan your day, and that you perhaps not become so stressed.'*

It is expressed that iHospital is a piece of a larger puzzle when you concern yourself with improvements of working environment for staff members in a hospital. In this connection, it can be mentioned that Horsens Regional Hospital have implemented different initiatives focusing on staff members' working environment. It can be mentioned in brief that the hospital has laid out a welfare strategy for all staff members in which focus is human resource management and development. Some of the specific initiatives that have been made on the basis of this welfare strategy are mentoring arrangements for newly qualified nurses, coaching of staff nurses in connection with management, strengthening of the HR department, employment of a wellness advisor (health checks, physiotherapy during working hours, running clubs, exercise offers, smoking cessation etc.), employment of more administrative personnel in order to release more time for management, healthy diet in the canteen and at meetings, shopping arrangement in online supermarket for the staff members, 'chill out room' for staff members and other initiatives.

Overall, the material from the questionnaire and interview survey gives an impression of a positive attitude among the staff members towards iHospital's influence on the working environment in the shape of better overview, fewer interruptions in the daily work and a positive impact on communication among staff members. Furthermore, staff members mention that the use of iHospital creates more peace during the working day. However, it should be mentioned that there is also a relatively large share of the consulted staff members who are neutral to the question concerning iHospital's influence on the working environment.

4.8 Derived consequences and possibilities with iHospital

Several times during the process of making this report and through interviews with the developers of iHospital and the management at Horsens Regional Hospital, we have been told that the request for a management tool was not the background for developing iHospital. On the contrary, the systems were to support working procedures which gave meaning to health professionals. Among other things, a person from central management states the following:

> *'So, as I remember, that was how it got started, and we discussed it a lot that it was essential that this did not become a "Big Brother is watching you", but on the contrary, it becoming support to self-help.'*

This story is told several times by several different people from management, and it stems from an actual wish to develop a system which is beneficial to health professionals in their daily work. At the same time, it is difficult as a leader not to be excited about all the data iHospital in reality collects and think these data into the hospital planning. This is clearly expressed in the quotation below.

> *'There is a spin-off of this, because we collect all data in a server from which we have the possibility to extract reports. So, what I talked about in the beginning, which we had tried so many times to get somebody to record, "what the hell is actually going on in this surgical ward?" The system simply collects this, because information is installed when it is programmed. And it is stored, so I can extract a report. Then I can say: 'What has my utilisation of the capital stock been?' Without having to make anyone record anything. It simply comes of its own accord.'*

Another management person talks about the possibility to utilise the collected data from iHospital on ward- and individual level. He says:

> *'And I believe that it is possible to collect data in a way that enables you to see that in some rooms the flow is better, the turnaround time between surgeries is faster, and perhaps relate it to who has had the responsibility for the operation of these rooms,both with regard to surgeons and nurses. Who is it that can make things work?'*

The interviews express a certain degree of incongruence both between the way in which iHospital has been introduced among the staff members and the management's potential future use of the system. However, this does not necessarily entail a conflict, but it depends to a great extent of the way in which the management chooses to use the collected data and present these to the staff members. One of the interviewed management figures expresses his opinion about how data from iHospital is to be utilised. He was asked if the management had discussed the administrative use of data from iHospital with the staff members of Horsens Regional Hospital, and he replied:

> *'(hesitant) I cannot say that we have discussed it with the personnel. But I think that it has been implicit from the start. But they have never been beaten on their heads with data. But you can say that it was well known that they were monitored. There are also cameras in the rooms and things like that. So, that part of it is not unknown. But it is not like it is to be used for anything bad. All things being equal, it is actually to be used to make people get a good working day out of it. That things are as a whole. And it is not a contradiction to patients getting a good day out of it. To me, these things are connected at any rate. It is not like that they will experience that we now come with iHospital data and then things have to be done. I do not think that they will experience it like that. Rather, I think that we can say that there are some focus areas, and then they will subsequently say: "Yes, we have also thought of that". Or, "We can also sense this". If we do our jobs properly, that is, then it will be the way they will experience it.'*

If you want to assist staff members support and enthusiasm in connection with the use of iHospital, it will likely be important how the potential administrative use of data from iHospital is used and presented to the staff members.

4.9 Development of iHospital and the context at Horsens Regional Hospital

In many ways the development of iHospital and the development at Horsens Regional Hospital cannot be separated from each other. As mentioned earlier, the basis for the analyses in this report is a sociotechnical approach, where technology and organisation are not seen as two separate parameters. If you follow the premises in this approach, you should perceive the development and implementation of iHospital as a part of that organisational development at Horsens Regional Hospital.

Knowledge about the organisational development at Horsens Regional Hospital is primarily collected by means of the conducted interviews.

As a starting point it should be mentioned that within the last six to eight years there has been a high degree of replacement among the management at Horsens Regional Hospital. According to statements from several of the interviewed individuals, these replacements in management have resulted in a notably different management style. In addition, more leading staff members mention that the establishment of the Danish regions in a way pushed Horsens Regional Hospital into a 'struggle for survival' in which no one knew which hospitals were allowed to 'survive'. According to statements from the management, this lead to the fact that Horsens Regional Hospital decided to implement a development, which would ensure that the hospital would survive the forming of the regions and would get at position in the new hospital structure in the region. One of the leading staff members expresses this very clearly as he says:

> *'Primarily, this is a result of the hospital management at the time stating that if we are to survive, then we have to be much more skilled, more clever and better. Well, you have to. And that mentality has been implemented in the hospital. And it proved successful. And it is crowned with the iHospital, The Golden Scalpel, and Denmark's healthiest company, and what we are seeing now is the crown of this. There has been a very focused effort. Basically, a struggle for survival, because if it was not done, then we were dead. That was the decision that this is not what we wanted. And iHospital is a part of it. But it does not stand alone, and it would not have brought survival if we had not included the other things. But it is part of the process taken place. That is the way I see it, at any rate. Now we have something to display.'*

In many ways, the participation in the development of iHospital seems to be an intentional, strategic action for the management's part in connection with branding Horsens Regional Hospital, both outwards and internally. Consequently, the development and implementation of iHospital is also to be seen as an integrated part of the organisational development and the struggle for survival at Horsens Regional Hospital.

In addition, a special connection has developed between Horsens Regional Hospital and iHospital. Both staff members at Horsens Regional Hospital and the researchers behind iHospital express that the development of iHospital has happened in an incredibly close cooperation between staff members from Horsens Regional Hospital and the researcher behind iHospital. First of all, the management at Horsens Regional Hospital did from the beginning of the project signal that the development of iHospital had a high priority and that involvement in it would be considered as working hours. A management representative relates the following:

> *'We said: Here we have a project. It is research. Those interested in participating can do so with pay, because they were bought out. In other words, if they were not working here but were engaged in the project, they were also paid for this. The fairs to Aarhus*

were covered and also the hours spent at Katrinebjerg in the laboratory. And I think it is important that the hospital said: This is important. Therefore, we have to not only draw on the voluntariness. Because then the project will take an awful amount of time. Because then it has to be coordinated and such. So it was included in the plan. That day, I am to go to iHospital. Okay, that is alright, you attend in that.'

Interviewer: 'Well. It was like an accept that it was -

That it was worth the money, it was -. This system was to be made by those who later were to use it. And not by the researchers. The researchers were those who said: Then you can do this and this. And I was to take part as executive, because I was to tell them: Fear not. Nothing is impossible. And this will give you great returns. You will become famous, and you will possibly benefit from it.'

The researchers behind iHospital also very clearly express the uniqueness in iHospital's development story. They say:

'I would like to say that what we have done in this project to make the clinical aspect closely involved like this -. All of a sudden, the clinical aspect and the Hospital of Horsens got to take up a great deal of space. That is something new. That is, the thing with the Hospital in Horsens suddenly becoming a test bed, that is something new. And when I am out to present this internationally, then one thing is that people think that what we have produced is extremely fine. And yes, everything is very good. But what in fact astonishes them the most is that we were allowed to do this at all. No other place in the world, perhaps except for Denmark, where there was a Chief Executive Officer, who allowed experimenting with patient in a surgical ward in that way. If you consider it, then it is a bit wild, what we had done. Because, what if it went wrong? Then you would be able to say that it was fortunately 'just' coordination and that sort of thing. It is clear that it is not some kind of new scalpel, or the like -, robot wielding scalpel we are testing. But still, it can actually have some consequences, if their entire coordination and communication completely breaks down. So, that is unique. And when I speak with American colleagues, then they are completely incomprehensible that it is at all possible. Because, you are not getting near a hospital unless you are authorised everywhere.'

These quotations show that the development of iHospital and the close cooperation between the researchers behind iHospital and the staff members at Horsens Regional Hospital have created a unique situationin which iHospital to a great extent is perceived as a technology developed *by* the staff members at Horsens Regional Hospital and *for* the staff members at Horsens Regional Hospital. The value of this 'development story' is hard to determine, but it must be presumed to have a positive effect on the staff members' perception of iHospital which will be difficult to transfer directly to other hospitals.

4.10 Discussion

Because iHospital is a newly developed technology and no other technologies are designed in the same way, there has not been much information to collect from the literature concerning the implementation of a system like it and concerning the organisational effects of an implementation like the one in Horsens. This leads to the majority of the collected knowledge and data that form the basis of the organisational analyses come from Horsens Regional Hospital. In this way, Horsens Regional Hospital is used as a case related to the study of the consequences and effects of implementing a system like iHospital.

This approach provides a snapshot of the situation at Horsens Regional Hospital in connection with the effects and consequences in the implementation of iHospital. Likewise, the case study approach can help create transparency and provide clarity of the possible consequences and effects of implementing a system as iHospital. Simultaneously it must be recognised that if focus is put on Horsens Regional Hospital as a case at a later time, the image will likely be different than it is at present. Some elements will remain the same, while other elements will constantly develop. This is due to both the development in the system behind iHospital and the natural development that takes place in every organisation.

Even so, it makes sense to draw conclusions on the basis of conditions at the current time which will provide valuable knowledge and information for other organisations that are considering implementing IT systems such as iHospital. Not least, the use of theory in the conducted analyses ensures a certain extent of generalisability in connection with the conclusions drawn in this paragraph.

4.11 Concise conclusion

The organisational analyses in connection with the implementation of iHospital show that the preconditions for streamlining the organisation concerning execution of the daily surgical programme are to a great extent provided by the use of iHospital in the daily work.

The organisation of the execution of the daily surgical programme must be characterised as being sequential, both before and after the implementation of iHospital. According to Mintzberg, the most important coordination mechanisms in the sequential course are standardisation of the process (content and timetable) and standardisation of professional competency/skills. In the sequential course, the transition from one action to the next is decisive to the process of the entire course of action, and that feature necessitates a tight communication and mutual adjustment between each of the constituent parts. Standardisation of content, timetable and professional competency also took place atHorsens Regional Hospital before the implementation of iHospital, and the results of the conducted studies and subsequent analyses show that the use of iHospital provides the basis for a close and smooth communication, and that staff members by means of the increased common consciousness have better opportunities to utilise the coordination and streamlining potentials that lie in the mutual adjustment.

Another part of the organisational analysis was to examine the staff members' attitude towards iHospital's influence on the working environment at Horsens Regional Hospital. Overall, the material from the conducted studies give an impression of a positive attitude among the staff members towards iHospital's influence on the working environment in the shape of better overview, fewer interruptions in the daily work and a positive impact on the communication between staff members.

The entire development and the implementation of iHospital at Horsens Regional Hospital have to be seen in the light of other organisational factors at the hospital. Considerable replacement in the management within the last six to eight years, restructuring, redeployment, focus on 'survival' in connection with the structural reform and general initiatives in order to create an attractive work place should be mentioned as important. It is not possible to leave the effect of these organisational factors out from the effect of the implementation of iHospital in an organisational analysis. Rather, it is relevant to perceive the development and implementation of iHospital as part of the development that the organisation of Horsens Regional Hospital has gone through during the latter years.

5 Economy

5.1 Background

In the HTA handbook it is recommended that an HTA report contains a health economic evaluation (cost-effectiveness analysis, cost-utility analysis, cost-benefit analysis or cost-minimization analysis) [28]. A health economic evaluation is a comparative analysis of the health-related and cost-related consequences of the implementation of a new technology.

The international literature only shows a handful of examples of health economic evaluations of IT in the field of health care. In a recent review of studies of pervasive computing within the field of health care, the authors do not find any health economic studies, but several studies which by other means describe economic consequences consisting of costs or potential cost reductions [12]. Within the broad field of health care IT, there are only few distinct health economic evaluations. An example is Kaushal et al., who tries to estimate the krone value of potential savings of a new computer-based decision support systems for diagnosing and launching of treatment through an expected reduction of medical errors on the basis of interviews and literature analysis [34].

A significant reason that so few analysts chose the traditional health economic methods is that can be very difficult to ascribe health-related consequences as a direct result of IT. Moreover, the value of health care IT will to a similarly great extent be reflected in strategic circumstances such as branding, recruitment, management information and so on.

As a result, the technology assessment handbook of IT-based solutions within the health sector recommends a more flexible approach depending on the situation and the use of several simultaneous methods and triangulation [18].

In the present economic analysis it is chosen to focus on the potential gains in productivity as a result of iHospital. The purpose of the analysis is to estimate a potential gain in productivity by the implementation of iHospital atHorsens Regional Hospital. Productivity is here defined as the relationship between output and input, for instance how many hospital services are provided for the money spent.

The background of the analysis is an assumption that iHospital provides the possibility for a tighter planning and execution of the daily surgical programme. An increased productivity can expectedly be realised, e.g. through a reduction in turnaround time, a reduction in the number of cancellations and increased actual operative period. This increase will be expected to happen, because with the new technology better possibilities for adjustment to continuous changes in the daily surgical programme will be achieved, including cancellations as a result of delays during the day, absent patients, acute surgeries, and other unexpected circumstances. Of particular importance is the expected better coordinator overview of personnel and facility resources, which will, among other things, enable coordinators to reorder the planned surgeries in time and place more quickly than before.

It should be noticed that the assumption of increased productivity is based on the same basic hypotheses about the effect of iHospital evident in chapter four about the organisational aspects from the implementation of iHospital.

- Better overview will assist to identify possible complications in the daily surgical programme quicker and subsequently help to find effective solutions.

- Better means of communication will help to inform about changes in the daily surgical programme quicker and more affectively and to get feedback on questions that may arise quicker and more effectively.

- Better support of coordination will provide better utilisation of the resources with many transfers and acute patients.

The organisational analysis showed that iHospital has formed the preconditions for better coordination and adjustment because of better overview, better communication possibilities and better support of coordination. The economic analysis tries to go one step further and study if this has also led to increased productivity.

The analysis of iHospital's effect on productivity at Horsens Regional Hospital is based on the results from the concise study below:

- Register study of the overall development in the hospital's productivity

- Time recording study in the operating rooms before and after the implementation of iHospital

- Questionnaire about the use of iHospital, changes in working procedures and opinions about iHospital

- Organisational case descriptions of workflow before and after the implementation of iHospital

- Interviews about the influence of iHospital.

For a quick evaluation of the concise studies' method, please read the overall method section.

The linkage of the partial results is carried out by means of analysis technique from a case study method. In brief, this is about [35]:

- The use of several data sources and methods to build a so-called 'chain of evidence' (like a courtroom) in order to ensure 'construct' validity (in other words, to ensure that the 'constructed measurement of productivity' actually measures what we want).

- To see patterns crosswise, to test competing explanations and to construct a logical coherent explanation to increase the internal validity (that is, to beconvinced that the interpretations/conclusions are right).

- To include theory in the analysis and interpretation in an attempt to increase the external validity/generalisability (in other words, that the results/conclusions will also apply for others).

First, a statement of the operating costs for acquisition and operation of iHospital is shown. Second, the results and concise conclusions of each of the concise studies concerning productivity are examined. Subsequently, a summary discussion of validity and reliability is made (method stringency) after which a main conclusion is put forward.

5.2 Results

5.2.1 Operating economy

The operating costs of iHospital are calculated as the costs of acquisition and establishment of the technology (the investment needed) and also operation and use of the technology.

The formation expenses are calculated in replacement prices (list prices excluding VAT April 2009) of Cetrea Surgical. The investment need of the central surgical ward (ten rooms) is approximately 2.5 million Danish kroner and approximately 4 million Danish kroner for the entire hospital, including coverage of the day surgery ward (six rooms). These amounts cover big screens, monitors in the operating rooms, software licenses, BookPlan integration and delivery.

The annual expense for service and maintenance is estimated at approximately 550,000 Danish kroner, hereof approximately 360,000 for the operating rooms.

Moreover, the resources which the hospital itself invests in the project are added in the form of project management, IT and technology. The use of project management hours concerning iHospital is estimated at a number of hours spent for a project manager to be eight hours a week for operation, corresponding to 416 hours per year, a total of 110,000 Danish kroner per year in actual salary. Annual variable costs for IT technician and technician is calculated to be approximately 100,000 Danish kroner in actual salary.

5.2.2 Result of the register study of the overall development in the hospital's productivity

Table 5.1 below shows the overall development in productivity at Horsens Regional Hospital in the period with iHospital in comparison with previous years. According to the table, Horsens Regional Hospital has realised a productivity increase from 2005 to 2008 defined as an increase in DRG value on a total of 7 %, corresponding to almost 2 % per year.

The DRG value in table 5.1 is calculated as the krone value of the hospital's total amount of surgeries defined on the basis of the department's collected patient discharges in the respective years. Expenditures to wages is calculated just as nursing expenditures in the surgical, care and anaesthetics departments (in other words, nurses, nurse anaesthetists, healthcare assistants, service assistants, social and service assistants and so on), that is without including the salaries for management and surgeons. It has not been possible to differentiate between surgeon expenditures related to surgery and physician expenditures related to other non-production related tasks (for instance, work on the outpatient clinics and research and administration). As a result, physician salaries are not included in the analysis. Other operations cover the material and activities costs, medicine, implants, clinical analyses and other medical items. Larger acquisitions are not included.

The development in the hospital's productivity is clarified by the changes in the calculated DRG rate, cf. table 5.1 below. The DRG rate is defined as DRG rate divided by the sum of expenditures for salaries (care) and other operations. It indicates the relationship between the krone value of input (the hospital's expenditures for salaries and other operation) and the krone value of output (the hospital's production calculated as DRG value). Moreover, the development is clarified by indexing the DRG rate with the year 2005=100.

It appears from table 5.1 that the DRG rate was at the same level in 2005 and 2006. It rose in 2007 resulting in approximately 3 % more DRG for the money spent than in 2005. In 2008 it rose further, resulting in an additional 7 % DRG for the money spent (from index 100 to 107).

Table 5.1 The development in productivity (DRG rate) at Horsens Regional Hospital in the period of 2005-2008 (fixed prices, index January 2005 = 100)

Danish kroner	2005	2006	2007	2008
DRG-value	171.336.513	165.389.864	175.147.247	181.284.485
Salary (care)*	24.807.990	24.538.240	26.247.447	27.081.789
Other operations**	20.198.063	19.523.988	18.574.303	18.2995.658
DRG rate *** (index 2005 = 100) (95 % confidence interval)	100 (94, 106)	99 (91, 108)	103 (96, 109)	107 (96, 119)
DRG rate corrected**** (index 2005 = 100) (95 % confidence interval)	100 (-506, 706)	66 (-222, 356)	218 (2, 434)	415 (37, 793)

Salary (care) for 2005 is imported on the basis of DRG, operation, monthly average in salary sum 2006-2008, and checked for annual shifts 2006-2008 ** A supplementary annual sum is included, which is allocated with 1/12th per month *** DRG rate is defined as DRG value divided by the sum of salary (care) and other operations **** Corrected DRG rate is subtracted monthly averages and a linear time trend.

However, this general development covers some big variations within each of the years. This appears from figure 5.1, which shows the DRG rate calculated per quarter.

Figure 5.1 The DRG rate calculated per quarter
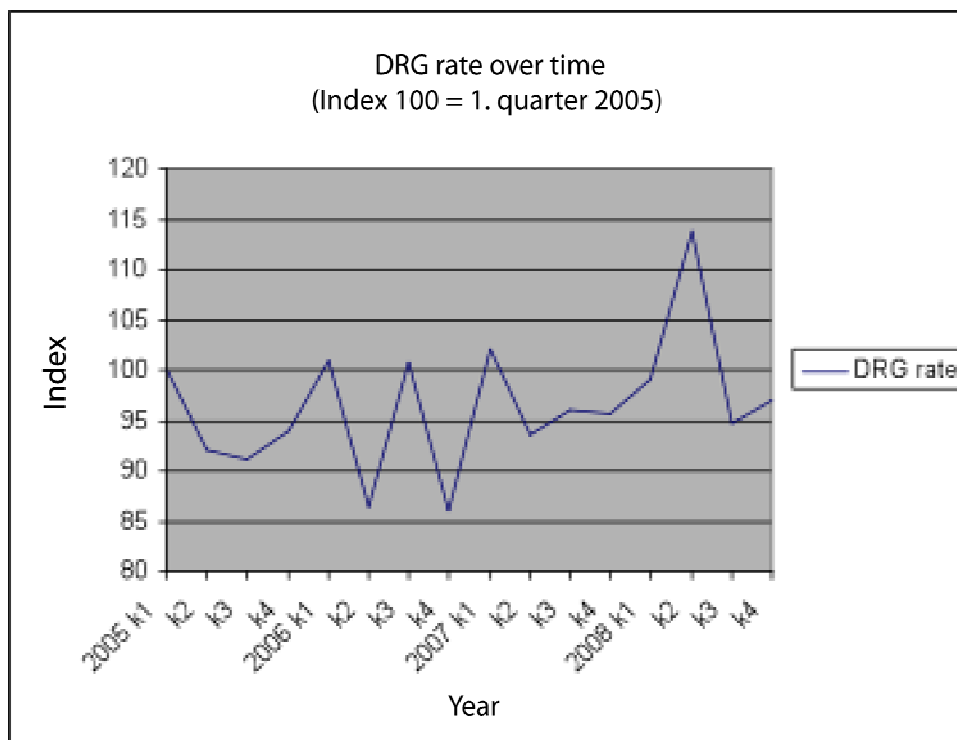
The dominating features in the figure are that there are some notable seasonal effects, and also that some dramatic events occurred in April-May 2008. As a significant explanation for the last, it can be mentioned that a 2 % saving at the hospital in the second semester of 2008 was intro-

duced as a derived consequence of the strained economy of Central Denmark Region. Further-more, the rate management model was suspended as of 16th April 2008 and replaced by a budg-etary management framework. A more 'technical' explanation for the seasonal variations over the years may be shifts in the accruals concept of costs for other operations in connection with the DRG value. The costs for other operations are registered in the period in which goods are delivered, which is not necessarily equal to the period of time of which goods are consumed in the production of DRG services. For instance this may concern larger purchases at a period of time (for example, by the end of a fiscal year) which are not consumed until the next fiscal year.

Figure 5.1 shows that the DRG rate was very unstable in 2006, after which it stabilised on a slightly higher level in 2007. For 2005, the DRG rate looked more stable, but this should be read with caution, because an estimation of the salary expenses was included in the calculation for that year, which stabilised the 2005 figures. However, these seasonal variations do not change the significant result that the DRG rate was on average slightly higher in December 2007 than in 2005. Moreover, the figures appear more stable in 2007 and 2008 - there were not the same great variations as in 2006.

Therefore, the interesting question is to what extent the increase in productivity as of 2007 can be ascribed to the implementation of iHospital and to what extent iHospital – other than a poten-tial slight rise in DRG rate - can also have contributed to stabilise the DRG rate.

In an attempt to analyse this further, a calculation of a corrected DRG rate defined as the month-ly DRG rate's deviation from the present monthly average is conducted for all four years. The corrected DRG rate is a calculation of the period's deviation from the 'norm', because the gen-eral time trend is 'subtracted'. The logic of subtracting the general time trend is that an even in-crease in productivity over the years with reference to a general technological development etc. is expected regardless of the implementation of iHospital. The corrected DRG rate shows shifts out of line with the general (increasing) trend.

According to the figures of the corrected DRG rate cf. table 5.1 above, the average deviation of the 12 months in 2006 was negative and in the size of two thirds of what it was in 2005. There-fore, an actual decline in the productivity in 2006 occurred. In 2007, the average deviation for the 12 months was positive and approximately twice the size as in 2005. Consequently, a sig-nificant progress in the productivity in 2007 occurred, which is probably ascribed the effect of all the initiatives that were implemented in 2007, also including the effect of the implementation of iHospital. In 2008, the growth continued to a level in the second quarter of 2008 that the av-erage of the entire 2008 compensated for the decline in the DRG rate in the end of the year. Fig-ure 5.1 shows that the conducted savings and suspension of the rate management model in sec-ond quarter of 2008 apparently worked like a slowdown, because the DRG rate went down in the short view, but subsequently straightened itself up again.

Summarised, this concise study shows that Horsens Regional Hospital has experienced a sig-nificant increase in productivity in 2007 and 2008, in other words in the period of time where iHospital was successfully implemented. However, the concise study does not explain anything about whether iHospital or other factors are the reason for this.

5.2.3 Result of the time recording study in the operating rooms before and after the implementation of iHospital

Table 5.2 below shows an outline of the collected data from the time recording in the operating rooms. Data was collected at two occations (autumn 2007 and autumn 2008, respectively), both times over a period of 14 days. Because the registrations took place in the same time of the year

with a one year interval, the bearing of a possible seasonal variation should be minimal. In both registration periods, information was collected in all nine operating rooms of the hospital.

Table 5.2 Number of surgeries divided between operating rooms before/after the implementation of iHospital

Room	Before iHospital	After iHospital	Total
1	15	20	35
2	26	20	46
3	0	68	68
4	0	57	57
5	19	41	60
6	0	63	63
7	3	3	6
8	0	62	62
9	19	32	51
Total (%)	82 (18)	366 (82)	448

According to table 5.2, time recording on a total of 448 surgeries was conducted, hereof 82 surgeries before the implementation of iHospital in the operating room in question and 366 surgeries with iHospital. Please notice that rooms three, four and eight had implemented iHospital at the time of the first time recording, while all rooms had iHospital at the last recording. Room six did not perform a recording at the first time of recording.

Different types of analyses of the collected data material were performed. Below is shown a calculation of the average share of the opening hours in the rooms which were utilised productive that is the share of the time in which surgeries was conducted. A total of 132 room days have had recordings carried out (N=132). In this calculation, the time consumption per surgery is defined as the time from the start of anaesthesia until the end of anaesthesia.

Table 5.3 Average percentage of room time which is utilised productive divided by room before/after the implementation of iHospital with 95 % confidence intervals

Room	Before iHospital	N	After iHospital	N
1	92 (82, 102)	7	88 (72, 103)	7
2	75 (51, 100)	8	79 (62, 97)	7
3	-	0	92 (84, 100)	20
4	-	0	93 (86, 99)	20
5	84 (57, 110)	5	75 (49, 100)	8
6	-	0	79 (59, 99)	10
7	69 (-,-)	1	60 (-,-)	2
8	-	0	94 (81, 106)	20
9	81 (63, 99)	7	87 (41, 132)	10
For all rooms	82 (74, 90)	28	88 (83, 94)	104
For rooms 1, 2, 5, 7 and 10	82 (74, 91)	28	82 (68, 96)	34
Total	87 (82, 91)	N = 132		

The table shows that the coefficient of utilisation is between 69 % and 92 % before and between 60 % and 94 % after the implementation of iHospital. The average utilisation for all rooms collectively rose from 82 % to 88 % (second last line in the table), and the figure before the implementation of iHospital (82 %) was significantly below the figure with iHospital (88 %), cf. the confidence interval for the 88 % which does not contain the figure 82.

Overall, this is an indication that the operating rooms with iHospital have had a more effective time utilisation. An increase from 82 % to 88 % corresponds to almost four minutes per hour of opening hours.

When only taking into consideration the rooms that have a before and after recording, however, the average coefficient of utilisation is unchanged on 82 % (cf. for room 1, 2, 5, 7 and 9).

In order to analyse whether the implementation of iHospital is associated with a better utilisation of the time in the operating rooms, a multiple regression of the coefficient of utilisation was conducted.

The multiple regression is carried out on room level per room date. The dependent variable is the percentage of total room time used productively. Because iHospital was implemented in three of the rooms in the first period of registration, statistically this provides the possibility to study the effect of iHospital and simultaneously correct for potential time trends. Therefore, a dummy variable for iHospital is partly working as an explanatory variable (is it implemented or

not), partly a time trend measured in days from the first observation. The coefficient for the time trend is -0.03, equal to a decline in 0.03 % per day or 1 % per month in the period. The coefficient for iHospital is 15.38, which means that rooms with iHospital have a percentage-wise time utilisation which is approximately 15 % higher than rooms without iHospital. Apparently the effect of iHospital is very clear, and it illustrates a significantly better utilisation of the time in the operating rooms after the implementation of iHospital. Both impacts are significant (on a 2 % significance level).

The slightly negative time trend in the observed period is directly consistent with the decline in the DRG rate, cf. table 5.1, and it should probably be read in the light of the general slowdown in the economy in the middle of 2008 as a result of the cut-backs in Central Denmark Region.

The significant coefficient for iHospital is also consistent with the results from the questionnaire, where, for one thing, 38 % of the staff members in the surgical ward and 47 % of the anaesthetics department (who owns the surgical ward and has the daily responsibility for planning and executing the surgical programme) agree that iHospital has lead to a better utilisation of the time in the operating room.

However, it is generally problematic to separate the effect of the iHospital from the time trend, that is, to precisely define what is what. Theoretically, it can be resolved by adding an interaction variable between the time trend and the iHospital dummy, but the data material is too modest to support this; it will lead to both the time trend, the iHospital dummy and the interaction part becoming insignificant.

Furthermore, the analysis includes no other factors which could have participated in increasing the coefficient of utilisation (for instance, a higher attention from the management's part to increase the productivity). Potential changes in input factors are thus not taken into account. It could be said that the interpretation of the result as an expression of increased productivity is made under the condition that factors of production are unchanged over time. (In principle, that it is the same surgeons and surgery personnel, same cost budget, same surgeries, same patients and so on). Of course, this is a rapprochement.

In order to study to what extent such circumstances may have influenced the result, it has been attempted to check for variations over time in input factors.

A change has occurred from 2007 to 2008 towards faster and less personnel-demanding surgeries. (It is assumed that the surgery time itself does not have anything to do with iHospital, because the surgeon's task ought in principle to be unchanged. It is primarily the turnaround between surgeries that can be changed by the implementation of iHospital). Expressed by simple mean values for 2007 and 2008 a slight decline in the number of staff members per surgery from 4.75 to 4.6 occurred, but this was not significant. On the other hand, a significant decline in the duration of each surgery occurred (in which the surgeries were divided into fast, medium and long procedures, respectively). Thus, it might have concerned a shift to shorter surgery types, but with an unchanged staffing level.

In the time recordings it was possible to identify type of surgery of 72 % of the surgeries. On the basis of the surgeries on which it was possible to measure resource and time consumption, the above regressions were repeated with two new dummy variables as a control. One was a dummy for resource-demanding surgeries and the other was a dummy variable for time-consuming procedures. More cut-offs (5-6 individuals, 4-6 individuals, 3 hours, 2-3 hours) were tested, but the analysis gave the same results with regard to time trend and the effect of iHospi-

tal. Overall, it did not change the image of the effect of iHospital to check for these variations in input factors. The coefficients only changed a few decimals and the effects were still significant.

The last analyses were conducted as logical regressions. As dependent variable the probability for the surgery getting cancelled or not was selected. The analysis was only conducted on the basis of completed or cancelled surgeries – transferred surgeries were excluded). The odds ratio for iHospital (dummy variable) was 0.344, showing that the probability for cancellation after the implementation of iHospital is only one third of what it was before. However, the figure is not significant, which must be ascribed to the limited number of cancellations (n=14) in the material overall. The figure should therefore not be rejected.

The odds ratio for iHospital with regard to upcoming surgeries on schedule (defined as starting not later than at 8 a.m.) is 1.50 (95 % CI from 0.38 to 6.01). This means that the probability for starting on time has risen with 50 %, apparently as a result of the use of iHospital. The figure is, as the confidence interval shows, not significant.

Summarised, the analyses of the time recordings demonstrate some tendencies which support that iHospital may have had a positive impact on the productivity. The weak significances do not imply that these tendencies should be rejected, rather they should to a large extent be ascribed the heterogeneity of the material.

5.2.4 Result of questionnaire about the use of iHospital, changes in working procedures and opinions about iHospital

The result of the questionnaire is described in detail in appendix nine. Below the most significant findings concerning productivity are summed up.

The study shows that among staff members there is a considerable visual (or passive) use of the monitors from iHospital. A total of more than 85 % of the staff members look at the surgical programme up to several times a day. Furthermore, the use of the monitors corresponds to the particular purposes ofdifferent personnel groups' functions in connection with the planning and execution of the surgical programme. In particular, the surgery personnel update the status arrow and the recovery ward types in patient statuses.

There is a clear indication that iHospital has provided an increased awareness level, illustrated by 64 % agreeing that they experience a better overview and 57 % who agree that they have got easier access to information. The increased awareness has had the impact in the daily work that 52 % now experience that it has become easier to manage changes in the daily programme. Theoretically speaking (cf. the overall method section) many of the changes that the staff members experience can be described as mechanisms which contribute to optimising the sequential course.

The results of the questionnaire support the assumptions of a better overview, better possibilities for coordination and better possibility for coordination, especially in the case of transfers and acute patients. The question is if these circumstances could also in practice be the foundation for fewer cancellations, less turnaround between surgeries, more surgeries, and when all comes to all, increased productivity.

Directly asked if iHospital has produced increased productivity, only 11 % agree while 18 % disagree. The majority replies either/or (30 %) or do not know (40 %). The attitude to questions about whether or not iHospital has produced an improved utilisation of the time in the operating rooms is slightly more positive. 29 % agree to this while 12 % disagree. Again, the majority of

the respondents reply 'do not know' (40 %) or either/or (17 %). Even bigger is the share agreeing that iHospital has entailed that staff members are able to perform their working tasks more effectively (31 %). Only 13 % disagree. The interpretation of these questions are difficult, in part because of validity issues (how do the respondents perceive the words 'productivity' and 'efficiency'?), and partly because many respondents, who does not work in the surgical ward, have probably not felt capable of answering these questions.

The subsequent analyses of who particularly believe that iHospital has resulted in increased productivity, increased efficiency and better utility of the time in the operating rooms indicate the general pattern that staff members with working tasks closely linked to the execution of the surgical programme are particularly positive towards iHospital. Personnel in the surgical ward, the anaesthetics department and central sterilisation department, or staff members with a coordinator role or many daily connections to other departmentsparticularly express increased efficiency and increased utilisation of the time in the operating rooms. Many of these differences between the departments are statistically significant.

Summarised, the questionnaire's results indicate that the implementation of iHospital may have contributed to an increase in the productivity in the hospital.Many of the preconditions which presumably would lead to an improved productivity are present with the implementation of iHospital (great agreement that iHospital has lead to improved overview, better communication and possibilities for better coordination). Moreover, it is especially staff members with coordinator roles or many connections to other departments who agree that iHospital has increased efficiency (34-41 %) and better utilisation of the time in the operating rooms (36-39 %) (significant variations). Only few agree (9-12 %) when directly asked if iHospital has caused an increased level of productivity.

5.2.5 Result of Organisational case descriptions of workflow before and after the implementation of iHospital

The overall conclusion from the case descriptions was that the workflow in the surgical ward did not change in the period of the implementation of iHospital. The organisational model is still sequential, and possible profits in productivity are not a result of fundamental changes in the organisation. Some work procedures, especially around communication and information, have changed with regard to contents and character and others have become superfluous. Many telephone calls have been substituted, because changes in the surgical programme are now communicated everywhere at the same time to all relevant personnel through the monitors.

5.2.6 Results about productivity from the conducted interviews

The objective of also including questions about productivity in the interviews was primarily to validate the assumptions about how iHospital might have an effect on the productivity. Could the interviews support the tendencies found in the quantitative studies on the basis of better overview, better communication and possibility for better coordination?

Regarding the question whether or not iHospital might have lead to fewer cancellations and less turnaround between surgeries, diverging attitudes were discovered and only limited backing.

A surgeon from the Department of Organ Surgery states the following:

> *'I probably incline to the view that there is not any (difference). I can see that there is more communication between the departments and the surgical ward. They do not call each other that often. I suppose that also is some kind of streamlining. But I really can-*

not see that it is supposed to make things speed up in the surgical ward or that you get it executed faster.'

A nurse coordinator expresses it like this:

'Some will probably say that that is what they believe. And others will say that they disagree. I do not think that it has changed my perception of being a coordinator. I can see that it (iHospital) has many good sides. Strictly overview-wise, that is. But whether it has saved time, or if it saves some things, I cannot say.'

Another nurse coordinator expresses support for the hypothesis about increased productivity – even though this apparently is marginal:

'Well, given that it eases the overview, you can some times deliver the information to the people who need to know faster. Some times you do not have to spend as much time on this. The time you spend locating people and get the information out can be what causes us to not have time for another one small task. If you are able to quickly get the information out, then it will result in that you perhaps have time for... (pause) ... if a room is suddenly finished, then it can quickly be communicated that there is a small task, and that you have the time for it before 3 o'clock.'

These statements are probably to be read with caution and cannot directly be used as a rejection of iHospital's significance for the productivity in the hospital. It is not certain that the staff members have experienced an increase in the productivity, because this has happened gradually over a longer period of time. Furthermore, the interviews showed that the word 'productivity' was interpreted very differently, sometimes even misunderstood as being a question about the number of patients. Finally, the hospital management has made it clear to the staff members that the objective with the implementation of iHospital was not to increase productivity. It is likely that the staff member's opinions on this issue might have be influenced by the internal dialogue about the purpose with iHospital.

On the other hand, the interviews illustrated that many other factors than iHospital have an influence on an efficient planning and execution of the surgical programme. As examples were pointed out the number of surgeons and patients, a new anaesthesia room which was introduced after the first measurement of time consumption in the operating rooms, after which some anaesthetic procedures did no longer need to be performed in the operation room, and a so-called 'lean light' project in 2007-2008 with focus on effective execution of the surgical programme. Finally, the threat concerning hospital closures in connection with the implementation of the structural reform could also have played a significant role.

A particularly consistent characteristic in many of the interviews was the significance of management focus.

A surgeon in the Department of Gynaecology states the following:

'When you scrutinise some of the working procedures which has been made when they made this, then there is always a pay-off one way or the other ...(and) ... But there has been more focus on this, also the thing with turnaround between surgeries. It might be that they could be streamlined even further. But I think that focus on it prompts that it can run a bit more efficient.'

A surgeon from the Department of Orthopaedics states the following:

> *'Yes, a change in the culture has happened lately ... more have been streamlined, and higher demands are put on people and the like. But it is also ... a changed management literally. Staff turnover.'*

Another consistent feature has been the emphasis of the economic control in the region as being significant for the number of surgeries.

An organ surgeon states the following:

> *'Till now, where it all got stopped after New Year, it was rate management. It resulted in the more we did, the more money we got. The more were we able to hire to perform surgery and so on. So, they intertwine, and it sort of started a positive spiral. Unfortunately, it has now stopped ... (and) ... And it has also something to do with the establishment of the region. More patients come and are being referred. There are fewer hospitals.'*

A surgeon from the Department of Gynaecology states the following:

> *'I believe that the shortage of surgeons we have had* (in the department) *has actually not affected the production as much. And you can wonder about that. But it is because it affects other things in stead ... (and) ... and it has something to do with – however, it is a long story. It has something to do with the region, because before, where we had earned extra for the department by doing additional tasks, now it is a budgetary management framework, and the budgets are being cut. So, it results in that we do not perform surgeries. We do not have the same level of activity as we had before.'*

These statements illustrates that the organisational context, as expected, has a great influence on the productivity development. It indicates that especially the financial management and incentive structure has had a great influence and that iHospital has probably been used as a tool in the ongoing planning and the adjustment of production and productivity in the hospital as a result of the general financial development. It should be emphasised that the statements do not directly say anything about the impact iHospital has had on the productivity. From a sociotechnical perspective, the introduction of a new system such as iHospital will be able to resound through the entire organisation because of the close connection between the constitutive elements in the working procedures. A change in one place can lead to changes in many other places, which perhaps in the end increases the productivity. So saying, iHospital may have lead to an increased productivity level, even though staff members in general do not connect iHospital with productivity gains, but relates productivity to other circumstances.

The interviews did not provide much support of a belief that a potential gain in productivity could be a result of iHospital delivering better management information for control and inspection purposes. One could imagine that the system could provide detailed information about each of the surgeons' and other personnel's speed and capabilities, which could be used actively in an attempt to get individual staff members to work faster. iHospital was simply not (yet) used for this purpose. (Please consult paragraph 4.8 about derived consequences and possibilities with iHospital).

The interviews are also used to assess to what extent the preconditions of the quantitative studies have been fulfilled. The assumption that iHospital has not likely had particular significance on the time consumption during the actual surgery (actual operative period) was thus supported even though there are now fewer interruptions/disturbances in connection with the actual sur-

gery and communication now happens directly to the surgeon electronically. A surgical nurse states:

> 'Well, they are not able to operate faster than they do. They cannot do that. It is also quality to be operated well and stop the bleedings properly and avoid second operations. It is still people we are dealing with.'

None of the interviewed expressed a conflicting opinion.

Finally, the interviews showed that a series of mechanisms which would explain a potential productivity improvement, have not been systematically retained by the selected methods in the financial analysis. This especially involves conditions outside of the operating rooms, e.g., in the central sterilisation department, the recovery ward and the wards. The ´respondents express an increased level of being able to plan their working day effectively.

A nurse from the recovery ward says:

> 'Well, if you know that you are to receive number one and number four for surgery at ten o'clock, then you might have time to wash three patients in the meantime, or have a conversation with your trainee, or make a follow-up telephone call. I think there are a lot of tasks you can insert, because you know that they will not arrive until ten o'clock … it is very good to plan according to this.'

The study does not take into account all the derived consequences of the implementation of iHospital. The examples of increased staff member satisfaction, cf. paragraph 4.7, might have affected the productivity because of increased motivation, just like the implementation of the system may provide staff members with a greater understanding of each others' working situations and, thus, more effective cooperation. A staff member from the central sterilisation department says:

> 'I have this "whoopee"-experience. And there are more things to it. For me and the department's part, iHospital has caused more focus on that there is a place in a hospital called the central sterilisation department.'

Summarised, the interviews can be interpreted as that the significance of iHospital on the productivity atHorsens Regional Hospital is probably to be seen in connection with the organisational context. This can explain that the development in productivity has been different in the period with payment per performance (DRG payment) and the period with budgetary management framework. When the incentive structure in the finance system dictates that as many patients as possible must be treated and thus providing a financial incentive to increase the number of surgeries, then iHospital can be a tool to optimise this process and has apparently been used with some success this far. Conversely, there is not much support in the interview material to believe that iHospital automatically was to result in more surgeries. Rather, it was the management's focus and the financing system that defined the changes in the level of activity.

5.3 Discussion

Five concise studies were conducted with the objective to estimate a potential productivity gain as a result of the implementation of iHospital at Horsens Regional Hospital. The productivity gain is estimated in DRG value (four % per year from 2006 till 2008), in average coefficient of utilisation in the operating rooms (rooms with iHospital have a time utilisation in percentages which is approximately 15 percent higher than rooms without iHospital), and also in opinions

among staff members with coordinator roles or many connections to other departments (34-41 % agree that iHospital has increased efficiency and 36-39 % agree that iHospital has caused better utilisation of the time in the operating rooms, while only 9-12 % believe that the productivity has increased because of the IT system). It can be rejected that the improvements in productivity of the observed period is caused by organisational reorganisations, but it can not be refused that other circumstances than iHospital have had a decisive influence.

Internal validity. Internal validity deals with whether the collected data and the interpretations hereof provides the proper image of iHospital's influence on the productivity at Horsens Regional Hospital. An important question is whether all five concise studies refer to the same phenomenon, in this case, ones understanding of the concept of 'productivity'. There is apparently a divergence between the quantitative measurements of DRG value, coefficient of utilisation in the operating room and the opinions in the questionnaire whether or not iHospital has lead to an increased productivity. This might have been caused by validity problems, because the respondents have different perceptions of what is meant by productivity, for example that someone perceives it as a question about whether the number of surgeries has increased as a result of iHospital. Seen in this light, some of the questions ought to have been phrased more adequately in the questionnaire.

It should also be noticed that the concept of productivity in the time recording study ignores gains from better planning of the staff members in the central sterilisation department, recovery ward and wards in the shape of relieved time for other purposes, better possibility to plan the working day, less stress and so on.

The gain when having five concise studies to draw on is that the collected assessment is more convincing, as long as all concise studies point in the same direction. Furthermore, the different methods and approaches provide better opportunities to test competing explanations and recognise patterns crosswise. However, the study has not unambiguously been able to demonstrate to what extent iHospital or other circumstances have contributed to the measured productivity improvement. Strategically, the data material has been too modest to check for many of the factors described in the interviews. In particular, it indicates that the structure changes and reorganisation of the financial management in the region have had a decisive impact on the productivity figures.

External validity. External validity (also called generalisability) refers to whether or not the study's results can be generalised, that is, transferred onto other hospitals. The strength of this study is that there is both theoretical and empirical foundation to state that the preconditions for increased productivity is created with iHospital because of a better overview, better communication and better possibilities for coordination. The basic hypothesis about overview, communication and coordination were strongly supported in both the questionnaire and the interviews. If these circumstances are utilised in the organisation, theoretically there are better possibilities for optimising the working procedures and this ought to be achieved in other hospitals as well.

5.4 Concise conclusion

There is both empirical and theoretical justification for stating that iHospital can improve the productivity. iHospital provides preconditions to obtain an increased productivity level, because better overview, better communication and better support of coordination are basic mechanisms for the optimisation of working procedures. Empirically, Horsens Regional Hospital has realised a measurable increase in productivity over the periodin which iHospital has been implemented. Time studies, economic key figures and a questionnaire all point in the direction of a productivity gain as a consequence of iHospital. However, it is not statistically possible to isolate the ef-

fect of iHospital from a series of contextual circumstances which also have affected the productivity, e.g. management circumstances, the municipality reform and reorganisations of financing circumstances in the region.

6 Patient perspective

6.1 Introduction

iHospital has not been developed as a technology which is directed at patients in hospitals. As mentioned earlier, iHospital was developed to support the working procedures for health professionals in connection with getting the daily surgical programme executed in the best possible manner. iHospital is not a technology which the patients get in contact with or which they can relate to, because they are not aware of iHospital's potential influence on their course of treatment. Consequently, it will not lead to usable results to ask patients about their experience of iHospital. The majority of the patients will not be able to make a comparison of a patient pathway before and after the implementation if iHospital.

During the development of iHospital different assumptions concerning circumstances were related to patients.

- iHospital was assumed to produce a better overview, which would reduce the number of unintended events in connection with the execution of the daily surgical programme.

- A better overview of the individual patient pathway would lead to staff members being able to deliver better and more accurate information to patients and relatives concerning the surgical procedure.

As stated, these assumptions cannot be tested directly by asking the patients about their experience and opinion about iHospital's influence on the number of unintended events or the quality of information provided to the patients. In connection with the unintended events, a qualitative analysis of the events was performed and reported to the Danish Patient Security Database. The assumption about better information to patients and relatives was tested by asking staff members about their perception seen in a before and after-perspective. The question about information to patients and relatives has been raised in both the questionnaire and through the conducted interviews.

6.2 Unintended events

As mentioned earlier, one of the objectives for developing iHospital was to provide the staff members with a better overview of the daily surgical programme. It was expected that the result of this better overview could be read off on several parameters. One of the main objectives of providing staff members with a better overview was to reduce the number of errors and unintended events. During interviews with the management at Horsens Regional Hospital and the researchers behind iHospital it was expressed that the reduction of unintended events was a significant motivation behind the development of iHospital. As one of the respondents states:

> *'…ideally, the system should function as a support to self-help. In order to avoid the unfortunate situation of participating in causing one of these unintended events that lead to handicap or death for any of the patients on which you perhaps performed the wrong surgery, because a mix-up had happened.'*

In this connection, quantitative analyses of unintended events do not seem to be an optimal solution. On the basis of the information from Horsens Regional Hospital, the reporting of unintended events to the Danish Patient Security Database appears to be 'uneven' over time. This irregularity can have several reasons, but it would be able to give a wrong image of the number of

unintended events over time. Likewise, all reporting and registration require a certain running-in period, before such a system operates optimally. The obligation to report unintended events first came in 2004, and it must be expected that the curve for the number of reported events rised in the years 2004 to 2008. Additionally, there are not, figure-wise, reported that many events that a decidedly quantitative before and after-analysis can be justified.

Therefore, a qualitative assessment of unintended events has been conducted. However, it cannot be checked whether unintended events have been avoided after the implementation of iHospital, sinceevents that have not occurred cannot be analysed, but it is possible to check if some unintended events was caused by the use of iHospital and if some unintended events possibly could have been avoided by the use of iHospital.

Selected staff members from Horsens Regional Hospital have examined all events which has been sent to the Danish Patient Security Database in the period 18 May 2004 to October 2008, and where the department is indicated as the anaesthetics department, Horsens Regional Hospital (the anaesthetics department have the responsibility for the surgical ward in Horsens Regional Hospital). In all, it concerns 207 cases which have occurred in the day surgery ward and the central surgical ward. All incidents have been printed as they were when they were reported in the database, that is, without the subsequent handling of cases. Afterwards, the quality coordinator and a head nurse from the surgical ward went through all cases one by one.

Eight episodes were considered episodes that potentially could have been avoided if iHospital had been implemented. No episodes of which circumstances about or use of iHospital were deemed to have a contributing cause to the incident were recorded. The eight episodes include:

- Poor planning of the daily surgical programme:

    o Patients with diabetes are put last in the daily surgical programme, which is not desirable with regard to the patient's condition (should ideally not fast too long).

    o Acute patient waits too long for surgery.

    o A surgeon has reported in sick. This message is not passed along to the surgical ward in the morning. It leads to a cancelled surgery in the end of the surgical programme.

- Surgery on another patient than expected:

    o The surgery staff does not find out that two surgeries have switched places until after completing surgery. Therefore, they have not performed surgery on the patient they thought.

    o An acute patient from the evening shift is put as no. one in the subsequent programme of the day. This is first discovered after finished surgery. The surgery staff has consequently performed surgery on another patient than they thought.

- Inadequate communication with the patient:

    o The surgery personnel did not speak with the patient before the surgery.

- Incorrect patient data on medicine sent to analysis:

      o   The medicine for one patient is brought in to an operating room in which surgery on another patient is being performed. Subsequently, the incorrect patient label is put on the medicine.

- Wrong prescription of medicine:

      o   Postoperative, the patient needs prescription on pain-relieving medicine but is prescribed medicine that he/she has already had.

The use of iHospital is considered to have been able to prevent these episodes from happening. For a more thorough assessment of the eight episodes and iHospital's potential contribution to prevent these, please read appendix ten.

A quantitative assessment of unintended events is an expression of the best offers of competent professionals as to how the situation would have turned out if the state of events had been different. Therefore it can not be considered an expression of that the eight events pointed out would have proceeded differently if iHospital had been implemented at the time. They are to be considered as the best estimates for events which might have been avoided if iHospital had been utilised optimally at the time.

6.3 Information to patients and relatives

When examining the results from the questionnaire, which are presented in appendix nine, in connection with the question concerning better information to patients and relatives, it is seen that 34 % of the respondents have replied that they think that the implementation of iHospital has allowed them to provide patients and relatives with better information about the surgical procedure. When looking specifically at the two departments that have the most contact with patients and relatives, namely the wards and the recovery ward, just below half and a bit more than half of the respondents, respectively, reply that after the implementation of iHospital they feel able to provide patients and relatives with better information about the surgical procedure.

This pattern is repeated in the conducted interviews. In these, the nurses clearly express that they feel capable of providing both patients and relatives with far better information about the patient's surgical procedure compared to what they were capable of before the implementation of iHospital. Contrary to this, other interviewed staff member groups do not see a noticeable difference in connection with being able to provide patients and relatives with information concerning the surgical procedure. This division of the staff member groups is understandable, because in most of the cases, staff members from the ward and recovery ward have the contact with patients and relatives concerning the expected surgical procedure. A nurse from a ward tells about the advantage of being able to provide more accurate information to the relatives: She says:

> *'I think it is a very big difference. And that we are able to follow them when the relatives call. Because in the afternoon, there are many who call when they get home from work, and ask: "How come we have not heard from our family member?" We can access and see that it is because the patient is still in the recovery ward, and to us it is natural that they are there for two to four hours. But it is also nice to be able to give information in stead of saying: "I actually do not know, but we have not gotten the patient back." Instead, you are able to give more accurate information. I think it is nice that you can reply that. "Unfortunately, I was the first to come in, I submitted my husband at a quarter past seven this morning, and I have not heard from his yet, and it is now three o'clock". "Why,*

that is because your husband did not get to surgery until at quarter past twelve". So -. Yes.'

The above quotation mentions the quality of the information to the relatives, but to the interviewed nurses from the wards, the quality of information to the patients has also been improved after the implementation of iHospital. When asked about the benefits of iHospital, a nurse says the following:

'Because, as you also mention, that you can just explain to a patient that an acute situation has been included. Everyone can understand this. And that information is important; and I would imagine that you would also think that yourself, if you lay there as a patient, that is. My toe can wait, for instance. Definitely both planning of the course of the day, and who is to use which rooms and which patients, and then passing on information to both relatives and patients.'

Data from the questionnaire and the conducted interviews show that a large share of these staff members who have direct contact with patients and relatives and who primarily is to inform about the timewise procedure of the actual surgery, find that iHospital gives a possibility for better and more accurate information to both patients and relatives.

6.4   Discussion

As mentioned before, iHospital is not a technology developed with a focus on the patient. The technology is developed with focus on the health professionals and their working procedures. Therefore, the patient perspective is also not the most obvious starting point for an analysis of iHospital. However, in the implementation of iHospital there was an expectation that the use of iHospital might reduce the number of unintended events and lead to better and more accurate information to patients and relatives about the actual surgical procedure. Strictly methodically, both these assumptions are hard to test and consequently the results from the ward must be interpreted with a certain degree of caution. The qualitative analysis of unintended events is based on the most qualified opinions from qualified professionals, but at the same time it is a hypothetical presentation of a sequence of events as they could potentially have developed.

In connection with the assumption about better and more accurate information to patients and relatives, it is not possible to ask patients and relatives in a before and after-perspective. Most patients and relatives have not been through a surgical procedure both with and without iHospital. Therefore, conclusions about these matters a drawn from secondary sources, namely the health professionals. The health professionals express that they feel that they can provide better and more accurate information to the patients and their relatives. The study cannot show if the patients and the relatives do experience getting better and more accurate information from the staff after the implementation of iHospital. However, it is expected that the health professionals have a good touch with this field in particular, because it is they who pass on information to the patients and the relatives. The results from the study do not indicate if the information received by the patients and their relatives are considered as adequate and comprehensive from their perspective. The results show that the health professionals feel that they can provide better and more accurate information to the patients and their relatives.

6.5   Concise conclusion

It is difficult to test one of the strongest motivations behind the development of iHospital directly, namely the reduction of unintended events. Several unintended events before the imple-

mentation of iHospital can be identified, which possibly could have been avoided, if the staff members in the hospital had had iHospital at their disposal and had utilised these opportunities optimally. This is probably the closest to an actual proof of iHospital's influence on the number of unintended events.

In connection with the assumption that iHospital can contribute to support a better and more accurate information level to patients and relatives, both the questionnaire and the conducted interviews illustrate that among the staff members, who primarily had the responsibility for passing on this information (the wards and the recovery ward), a large share feel that the implementation and use of iHospital enables them to deliver better and more accurate information to patients and relatives. The overview of the entire surgical programme and the different patient status markers, which are used in iHospital, are causing the staff members to experience the information as better and more accurate.

7 Overall evaluation and perspectives

The objective of this report is to examine if the implementation of iHospital has lead to a streamlining of the organisation concerning execution of the daily surgical programme and the work in the the surgical ward in general at Horsens Regional Hospital. Likewise, there has been a wish to clarify the staff members' attitude towards iHospital. In the report, the following elements are included:

- Technology

- Overall method section

- Organisation

- Economy

- Patient perspective

Because of the selected data collection methods (literature evaluation, observations, interviews, questionnaires, time recordings, register data and qualitative assessment of unintended events) and analysis of the collected data, a collected evaluation and perspectives can be made.

7.1 Collected evaluation

7.1.1 HTA of IT systems

Several challenges occur in connection with conducting an HTA of IT systems. First of all, in the literature it is unusual to find evaluations or information about the use of such systems within the field of healthcare and the effects hereof. Secondly, these systems have a tendency to develop swiftly over time. In practice, this means that it is almost impossible to perform an evaluation of an unchanged system from development over implementation and to stable operation.

To measure the efficiency and productivity in connection with the implementation of new IT systems is a difficult task, because often the effect of such systems is to be found in many places in the organisation. It is also difficult to isolate the effect of these systems from the effect of other factors in the organisation.

7.1.2 Conclusions

Overall, the organisational analyses show in connection with implementation of iHospital that the preconditions for streamlining of the organisation concerning execution of the daily surgical programme are to a great extent provided by the use of iHospital. This may be because a better overview, better communication and better support of coordination are some basic mechanisms for optimising working procedures. Furthermore, the material from the conducted studies give an impression of a positive attitude among the staff members in connection with iHospital's influence on the working environment in the shape of better overview, fewer interruptions in the daily work and a positive impact on the communication between the staff members. More specificly, it was established that:

- 64 % of the consulted staff members agree that they have gotten a better overview.

- 57 % of the consulted staff members believe that they have gotten easier access to information.
- 52 % of the consulted staff members experience that it has become easier to manage changes in the daily programme.

In connection with the financial analyses concerning productivity, there is both empirical and theoretical justification to state that iHospital can improve the productivity. As mentioned above, iHospital creates the preconditions to obtain an increased productivity. Empirically, Horsens Regional Hospital has realised a measurable increase in productivity during the period of the implementation of iHospital. Time studies, financial key figures and the questionnaire all point in the direction of a productivity gain as a consequence of iHospital.

However, both in the organisational analysis and in the financial analysis, it is not possible to isolate the effect of iHospital from a series of contextual circumstances which have also affected the organisation, the work environment and the productivity. This issue is both statistical and analytical in evidence. Among the contextual factors which have also had an influence on the mentioned parameters are the municipality reform, the reorganisation of financial circumstances in the region, replacements in management, a general focus on working procedures in connection with the execution of the daily surgical programme and general initiatives to create an attractive work place.

iHospital is not a technology developed with focus on the patient. The technology is developed with focus on health professionals and their working procedures. However, in the implementation of iHospital there was an expectation that the use of iHospital might reduce the number of unintended events and lead to better and more accurate information to patients and relatives about the actual surgical procedure. Both these assumptions are hard to test metodically, and consequently the results from the ward must be interpreted with a certain degree of caution.

A qualitative analysis of the unintended events was conducted and the results pointed to some events that perhaps could have been avoided if iHospital had been implemented at the time of the occurring events. These results are based on the best opinions of qualified professionals, but they must be considered hypothetical, because it cannot be predicted how the process actually would have turned out with the use of iHospital.

In connection with the assumption that iHospital can support better and more accurate information to patients and relatives, both the questionnaire and the conducted interviews illustrate that a large share of the staff members experience/feel that the implementation and use of iHospital enables them to provide better and more accurate information to patients and relatives.

7.2 Perspectives

As far as we know, this HTA is one of only few attempts to execute a collected evaluation of implementation of a new IT system in the health care sector within an HTA framework. Thus, it is per se also an 'experiment' in connection with studying how far the concept of HTA goes when concerning oneself with this type of issue.

The report illustrates that usable results can be obtained by using HTA as analysis framework for the implementation of IT systems within the health care sector. One of the benefits of this analysis framework is that several aspects of the implementation are tried in the same study and, by doing so, it provides the opportunity to discover the mutual dependency between the different aspects. However, it is also clear that if you choose to use an HTA as the analysis frame-

work for the implementation of IT systems, it is recommendable to use a comprehensive set of methods. In traditional HTAs, much focus is methods-wise put on systematic literature searches and systematical evaluation of the found literature, but within this field of issue it is recommendable to include different methodsin order for the issue to be clarified from different angles. This is in evidence because there is not much literature about effect of the implementation of IT systems in an organisation, and because the effect of such an implementation will often be found different places in the organisation.

Seen in the light of the many IT systems implemented in the health care sector in these years, it would be useful to start a method development which makes it possible to evaluate the implementation of IT systems within a collected HTA perspective. In the present HTA, the methodical starting point is the idea of a case study. Here, the implementation of iHospital at Horsens Regional Hospital as one collected case where the consequences and effects of such an implementation is clarified from different angles and with different methods, and where some of the methods are aimed at being used in a before and after-design.

The benefit of using the case study approach is that the conceptual and internal validity of the study's conclusions are increased. The drawback is that most of the knowledge used to draw these conclusions is derived from this single case. How is it possible to relate to the external validity (generalisability) in such a study? In this HTA, different theories in the analysis of the collected data have been used in order to increase the external validity, but as mentioned above, the results from this study cannot be transferred to whichever other organisation uncritically and completely. As described in the sociotechnical approach, technology and organisation are inextricably linked, and the effect of the implementation of IT systems will consequently depend on the context in the organisation in question.

Compared to the external validity of the report's results it should be emphasised that this HTA is exclusively executed on the basis of implementation of iHospital in the central surgical ward at Horsens Regional Hospital and the cooporating departments (wards, recovery ward and central sterilisation department). It has not been examined if the system would be capable to deliver the same effects in other organisational set-ups. In addition, there is a limitation in the economic analyses concerning productivity, which means that productivity is only measured in connection with the central surgical ward. The efficiency improvement which would perhaps occur in the wards, in the central sterilisation department and in the recovery ward as a result of implementation of iHospital has not been included in the productivity analysis, by which the effect can be underestimated.

An HTA like this can take part in creating a certain form of transparency and clarify what happens when a system like iHospital is implemented in a concrete organisation. This report, thus, can take part in ensuring a good basis for decision-making concerning a possible implementation of iHospital in other hospitals in Denmark. The use of theory in the conducted analyses ensures a certain degree of generalisability of the results discovered, meaning that some of the discovered effect of the implementation of iHospital at Horsens Regional Hospital can be expected to transferrable to other organisations. The report also illustrates what is required of an organisation when implementing a system like iHospital if the organisation wants to achieve a good effect of such an implementation.

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9 Appendix

Appendix summary

Appendix 1:
Guide to interview with the researchers behind iHospital

Appendix 2:
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Appendix 7:
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Appendix 1:

Guide to interview with the researchers behind iHospital

Background for iHospital

- How did the idea for iHospital arise?

- Who had the original idea, and who contacted who?

- Who was the instigator of the collaboration with the hospital in Horsens?

- Did or does the project enter into a larger research-related context at Aarhus University?

Objectives and goals with iHospital

- What was the purpose of developing iHospital?

- Which thoughts and ideas were behind the development of iHospital?

The environment at Horsens Regional Hospital.

- How were the hospital's other systems considered into the development of iHospital?

- Were there any thoughts in correlation with the organisation in the Horsens Regional Hospital (changing the system in the organisation/the organisation of the work)?

The cooperation with Horsens Regional Hospital

- Can you specifically describe the cooperation with Horsens Regional Hospital?

- Was there a need for instruction/training, and how did you participate in the instruction/training (learning strategies/word of mouth/random training)?

- Has there been a possibility for system support for the staff members at Horsens Regional Hospital?

- Is there something you would have done differently, if a similar collaboration was to be launched?

Recapitulation

- What has the development of iHospital been like compared to your expectations?

- What went well in the project, and what went less well?

Background for iHospital:

- How did the idea for iHospital arise?

- Who had the original idea, and who contacted who?

- Who was the instigator of the collaboration?

- What made you decide to go from pilot test to operation?

Objectives and goals with iHospital:

- What was/is the purpose of developing iHospital?

- What are the all-important goals with the implementation?

- What did you wish to achieve with the implementation of iHospital?

- Have new goals arisen?

- Have the expectations to the system changed during the process in correlation with effect and what it is possible to achieve?

Implementation and education in correlation with iHospital:

- What were the considerations concerning the implementation of the system in correlation with organisation, staff members, work-sharing etc.?

- Which areas of specialty/tasks were/are represented in the internal working group concerning iHospital?

- What was done specifically in connection with implementation (education, training, information, orientation etc.)?

Recapitulation:

- What has the development with iHospital been like compared to the expectations?

- What does it mean for Horsens Regional Hospital to be in posession iHospital?

Appendix 3:

Guide to interview with coordinators at Horsens Regional Hospital

Background questions:

- For how long have you been employed at Horsens Regional Hospital?

- What is your designation of occupation?

- For how many years have you managed the coordinator function in the surgical ward?

- I addition to the implementation of iHospital, has other major changes happened to the co-ordinator work while you have managed this function?

Description of workflow:

- We will ask you to perform an exercise which we know may be difficult. If you think back to the time before the implementation of iHospital, please try to describe your typical working day as a coordinator. What were your tasks, how did you execute them, what was hard and where did problems often occur?

- Now, we will ask you to describe a typical working day for you as a coordinator after the implementation of iHospital. Have your work assignments changed, do you perform your work assignments in the same way as before, do the same difficulties and problems occur, have new difficulties and problems occurred?

- We will ask you to perform an exercise which we know may be difficult. If you think back to the time before the implementation of iHospital, please try to describe what happened from the moment a patient was hospitalised in one of the wards and prepared for surgery and till the same patient was back in the ward again.

- Now, we will ask you to describe the same patient flow after the implementation of iHospital.

Additional questions which can be asked during the description of workflow:

- Has the implementation of iHospital given you a better opportunity to follow what your colleagues are doing and where they are during the working day?

- If yes – how can you use this knowledge in your daily work?

iHospital and working environment:

- Is it your opinion that the implementation of iHospital has had influence on your working environment?

o Better overview

o Less stress

- Does public recognition of Horsens Regional Hospital mean anything to you personally (job satisfaction)?

- Does the management focus on coordinating tasks mean anything to the working environment/job satisfaction?

- Are there better opportunites to plan your own working day after the implementation of iHospital?

- Has the working environment among staff members changed after the implementation of iHospital?

- Can you think of other reasons for the potential changes in the working environment?

Planning of the daily surgical programme:

- Has the implementation of iHospital changed your conditions for planning the daily surgical programme?

- Is it your opinion that there are fewer cancellations in the surgical programme after the implementation of iHospital?

  o If yes, what have made the fewer cancellations possible?

- Is it your opinion that the hospital completes more surgeries per day after the implementation of iHospital?

  o If yes, what have made the completion of more surgeries per day possible?

- Can you think of other factors which may have had influence on cancellations and the completion of the number of surgeries?

Time consumption in connection with the development of and training in the use of iHospital:

- Time consumption for workshops, meetings or the like in connection with the development of iHospital?

- Does it take longer for new staff members to be trained in the use of iHospital than in the use of the old 'paper-based system'?

- Are there tasks/routines which take longer when they are executed after the implementation of iHospital?

- Are there tasks/routines which take less time when they are executed after the implementation of iHospital?

Appendix 4:

Guide to interview with physicians at Horsens Regional Hospital

Background questions:

- For how long have you been employed at Horsens Regional Hospital?

- What is your designation of occupation?

- For how long have you been employed in this occupation?

Mechanisms behind the surgical programme:

- Which factors are crucial to how the surgical programme is planned?

    o   Patient composition

    o   Personnel composition

    o   Number of days the surgeons perform surgery

    o   Number of surgeries one surgeon completes per day.

The use of iHospital:

- How do you use iHospital in your daily work?

- Are there any work routines which has changed after the implementation of iHospital?

- Are there tasks/routines which take longer when they are executed after the implementation of iHospital?

- Are there tasks/routines which take less time when they are executed after the implementation of iHospital?

Streamlining:

- When we talk to people about iHospital, two different opinions are expressed in general:

    1. The implementation of iHospital has taken part in streamlining and optimising the organisation around the surgery procedure in a way that it is possible to complete more surgeries per day and fewer cancellations occur.

    2. The implementation of iHospital is very fine; however, it has not changed anything in correlation with streamlining in the surgical ward.

- What is your opinion on this question?

- Our preliminary statements indicate that after the implementation of iHospital an increase in the average actual operative period in the operating rooms has occurred, so that surgeries are performed in a greater share of the operating rooms' opening hours. In addition, it seems that the timeof which the patients are in anaesthesia has become shorter.

- In your opinion, can there be other reasons for these results besides the implementation of iHospital?

- Number of staff members? Are more staff members employed? Has there been shortage in staff before?

- Has the changed patient basis after the formation of the regions had any influence on the composition of the surgical programme? Are there more/fewer patients? Other types of surgeries? Are more/fewer patients referred from other hospitals?

- Have changes occurred in the surgical programme? Other types of surgeries (DRG)?

- Is the productivity in the surgical ward regulated by economy? In other words, have management decisions been made which may influence the surgical programme/-productivity? For instance, the number of days a surgeon is to operate a week.
- Focus on certain types of surgeries.
- Other Reasons …………….....

Appendix 5:

Guide to interview with surgical nurse at Horsens Regional Hospital

Background questions:

- For how long have you been employed at Horsens Regional Hospital?

- What is your designation of occupation?

- Have you always been employed in this occupation?

Description of workflow:

- We will ask you to perform an exercise which we know may be difficult. If you think back to the time before the implementation of iHospital, please try to describe your tasks during the execution of a surgery. What were your tasks, how did you execute them, what was hard and where did problems often occur?

- Now we will ask you to describe your tasks during a surgery after the implementation of iHospital. Have your work assignments changed, do you perform your work assignments in the same way as before, do the same difficulties and problems occur, have new difficulties and problems occurred?

- Which areas of specialty/departments are you typically in contact with during your working day?

    o How did you contact these individuals before the implementation of iHospital?

    o How do you contact these individuals after the implementation of iHospital?

    o Has it become easier to reach the relevant individuals after the implementation of iHospital?

Planning of the working day in the operating rooms:

- Has the implementation of iHospital changed the conditions for planning the daily work in the operating rooms?

- Is it your opinion that there are fewer cancellations in the surgical programme after the implementation of iHospital?

    ° If yes, what have made the fewer cancellations possible?

- Is it your opinion that the hospital completes more surgeries per day after the implementation of iHospital?

    ° If yes, what have made the completion of more surgeries per day possible?

- Can you think of other factors which may have had an influence on cancellations and the completion of the number of surgeries?

iHospital and working environment:

- Is it your opinion that the implementation of iHospital has had an influence on your working environment?

    ° Better overview $\Rightarrow$ less stress

- Does the management focus on your work and working procedures mean anything to the working environment/job satisfaction?

- Do you have better opportunites to plan your own working day after the implementation of iHospital?

- Has the working environment among staff members changed after implementation of iHospital?

- Can you think of other reasons for the potential changes in the working environment?

Time consumption in connection with the use of iHospital:

- Does it take longer for new staff members to be trained in the use of iHospital than in the use of the old 'paper-based system'?

- Are there tasks/routines which take longer when they are executed after the implementation of iHospital?

- Are there tasks/routines which take less time when they are executed after the implementation of iHospital?

Quality in the treatment:

- In your opinion, can iHospital take part in the prevention of certain forms of unintended events?

Appendix 6:

Guide to group interview with ward, recovery ward and central sterilisation department

- **Introduction:** We come from Centre for Public Health and we are employed in the department of HTA and Health Services Research. The management here at the hospital have asked us to make a health technology assessment in correlation with the implementation of iHospital. Today, we are to discuss your use of iHospital in the daily work and your experiences with iHospital. We are also going to discuss both the concrete use of iHospital and your opinions and attitudes towards iHospital.

- **Rules:** Everyone has a right to say something, and all contributions are welcome. The objective of this interview is to clarify the subject on the basis of the different experiences you have had with iHospital. That is, it is not the intention that we are to reach an agreement about how iHospital is used or which opinion/attitude the individual should have about iHospital.

- **Reasons why you have been selected to participate:** We have chosen to make a group interview with representatives from the central sterilisation department, the recovery ward and the wards, because all these departments are in a way outside of the surgical ward, but they have close collaboration with this. Therefore, we have asked to have two representatives from these departments to participate in the interview, and that is why you are selected. We are aware that you have very different working tasks, but it does not matter.

- **Round of introduction:** Now, I would like to ask each of you to introduce yourselves by name, occupation and department. Subsequently, you may in brief explain how you use iHospital in your daily work.

- **Working procedures before and after the implementation of iHospital**

    o Are there any routines in your daily work that you perform differently after the implementation of iHospital?

    o Has the contact/communication with other personnel/other departments changed after the implementation of iHospital?

- **Contact/communication/connection with the surgical ward**

    o How is your connection/communication with the surgical ward after the implementation of iHospital?

    o Has the potentially changed connection/communication meant anything for the work in your department?

iHospital and working environment:

- Is it your opinion that the implementation of The Interactive Hospital has had influence on your working environment?

    o Better overview / less stress

- o Does the management focus on your work and working procedures mean anything to the working environment/job satisfaction?

- o Do you have better opportunities to plan your own working day after the implementation of The Interactive Hospital?

- o Has the working climate among the staff members changed after implementation of The Interactive Hospital?

- **Streamlining**

  - o Which associations do you get when you hear the word 'productivity' – or stated in another way – how do you understand the word 'productivity' in connection with your work?

  - o Do you think that implementation of iHospital has either reduced or increased the productivity in correlation with your work?

- **Quality**

  - o Do you think that the implementation of iHospital has any influence on the number of unintended events in connection with your work?

  - o Can you give some examples of which type of unintended events that could occur in connection with your work?

- **Advantages/disadvantages of iHospital**

  - o In your opinion, what are the biggest advantages of using iHospital?

  - o In your opinion, what are the biggest disadvantages of using iHospital?

Appendix 7:

Questionnaire

SPØRGESKEMA VEDR. DET INTERAKTIVE HOSPITAL

1 **Er du:** Kvinde ☐ Mand ☐

2 **Hvornår er du født?** ⎵ ⎵ ⎵ ⎵ ⎵ ⎵
dag måned år

3 **Hvilken afdeling/afsnit er du tilknyttet?**

Operationsafdelingen ☐	Anæstesien ☐	Opvågningen ☐
kirurgisk afdeling ☐	Ortopædkirurgisk afdeling ☐	Kvindeafdelingen ☐
Sterilcentralen ☐	Serviceafdelingen ☐	↵ Andet ☐

Hvis andet, specificer: _____

4 **Hvor lang tid har du været på afdelingen/afsnittet?** ⎵ ⎵
år

5 **Hvad er din stilling/funktion?** (sæt evt. flere kryds)

Anæstesilæge ☐	Anæstesisygeplejerske ☐	Sygeplejerske ☐
Organkirurg ☐	Ortopædkirurg ☐	Gynækolog ☐
Urolog ☐	Operationspersonale ☐	Opvågningssygeplejerske ☐
Sosu-assistent ☐	Ansat i sterilcentralen ☐	Servicemedarbejder ☐
		↵ Anden ☐

Anden stilling/funktion: _____

6 **Har du af og til en af disse roller?**

OP-koordinator ☐	Anæstesi sygepl. koord. ☐	Anæstesi læge koord. ☐
Tavleansvarlig ☐	Nej - ingen af disse roller ☐	

7 **Hvilke af disse afdelinger/enheder er du i kontakt med for at udføre dit arbejde?**
(sæt evt. flere kryds)

Sengeafdelingerne ☐	Opvågningen ☐	Sterilcentralen ☐
Operationsstuerne ☐	Koordinatorcentralen ☐	Anæstesien ☐
Servicemedarbejder ☐	Patienthotel ☐	↵ Andre ☐

Hvis andre, da hvilke: _____

8 **Hvordan har du lært at bruge Det Interaktive Hospital?** (sæt evt. flere kryds)

Igennem planlagt undervisning ☐	Brugervejledning (manual) ☐	Af kolleger ☐
Af personer fra IT-firmaet ☐	Prøvet mig frem ☐	↵ Andet ☐

Hvis andet, specificer: _____

Center for Folkesundhed, Olof Palmes Allé 15, 8200 Århus N, Att.: Lotte Groth Jensen (tel. 87284756)

9   **Hvor ofte bruger du skærmene fra Det Interaktive Hospital i dit daglige arbejde?**

	mere end 10 gange dagligt	5-10 gange dagligt	1-4 gange dagligt	sjældnere/ aldrig
Ser på operationsprogram	☐	☐	☐	☐
Ændrer i operationsprogram	☐	☐	☐	☐
Indskriver patientstatus	☐	☐	☐	☐
Sender beskeder/chatter via systemet	☐	☐	☐	☐
Opdaterer statuspil	☐	☐	☐	☐
Ser på videobilledet	☐	☐	☐	☐
Ser hvilket team jeg skal arbejde med/i	☐	☐	☐	☐

10   **Hvor *enig* er du i følgende udsagn?**

"Indførelsen af det interaktive hospital har betydet …

A   *… at der er færre afbrydelser i mit daglige arbejde"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

B   *… at jeg har et bedre overblik over dagens arbejde"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

C   *… at jeg sparer nogle skridt i løbet af min arbejdsdag"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

D   *… at jeg har nemmere adgang til de informationer, der er relevante for at udføre mit arbejde"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

E   *… at jeg skal udføre ekstra arbejde i forhold til tidligere"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

F   *… at jeg kan give patienter og/eller pårørernde bedre information om operations- forløbet"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

G   *… at jeg kan udføre mine arbejdsopgaver mere effektivt"*

☐	☐	☐	☐
enig	hverken/eller	uenig	ved ikke

11 **Hvor *enig* er du i følgende udsagn?**

"Indførelsen af det interaktive hospital har betydet ...

A *... at det er blevet lettere at få kontakt med relevant personale på hospitalet"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

B *... at det er blevet lettere at koordinere samarbejdet med relevant personale på hospitalet"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

C *... at det er blevet nemmere at håndtere, når der sker ændringer i dagens operationsprogram"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

D *... at det er blevet nemmere at kommunikere med relevant personale på hospitalet"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

E *... at kommunikationen mellem afdelingerne er blevet bedre"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

F *... at hospitalet er blevet 'knyttet tættere sammen'"*

☐ enig ☐ hverken/eller ☐ uenig ☐ ved ikke

12 **Har du indtryk af, at indførelsen af det interaktive hospital har øget produktiviteten på Regionshospitalet Horsens?**

☐ ja ☐ nej ☐ hverken/eller ☐ ved ikke

13 **Tror du, at det ville være en god idé at indføre det interaktive hospital på de større hospitaler i Danmark?**

☐ ja ☐ nej ☐ hverken/eller ☐ ved ikke

14 **Mener du, at indførelsen af det interaktive hospital har medført bedre udnyttelse af tiden på operationsstuen?**

☐ ja ☐ nej ☐ hverken/eller ☐ ved ikke

15 **Mener du, at det interaktive hospital kan være med til at mindske risikoen for utilsigtet hændelse?**

☐ ja ☐ nej ☐ hverken/eller ☐ ved ikke

16   Hvad er efter din mening det mest nyttige ved det interaktive hospital?

_____

_____

17   Hvad er efter din mening mest uhensigtsmæssigt ved det interaktive hospital?

_____

_____

18   Så er der ikke flere spørgsmål. Du er velkommen til at komme med uddybende kommentar til undersøgelsen.

_____

_____

Appendix 8:

Registation form

Regionshospitalet Horsens
Registrering af operationsaktivitet på operationsafdelingen

Stue	
Dato	
Faktisk åbningstid/lukketid	

	1. operation	2. operation	3. operation	4. operation	5. operation	6. operation	7. operation	8. operation
CPR-nr.								
Operationstype								
Akut/planlagt								
Aflyst								
Operationen flyttet til anden stue								
Anæstesi start								
Operation start								
Operation slut								
Anæstesi slut								

Udfyldt af: _____

Udfyldes for alle akutte og planlagte operationer.
En akut operation markeres med et **A**, mens en planlagt operation markeres med et **P**.
Planlagte operationer er operationer, som fremgår af operationsprogram lagt på konference dagen i forvejen.
Hvis en planlagt operation bliver aflyst, skrives **AFLYST** i den kolonne.
Hvis operationen **flyttes** til anden stue sættes et kryds i denne kolonne.
Den planlagte åbningstid er: 07.50 – 14.40

Appendix 9:

Results from the questionnaire

In the following, the results from the questionnaire are examined. First it is accounted for who has filled out the questionnaire and some general information about the respondents' gender distribution, age, terms of employment etc. are presented.

Subsequently, the results concerning the respondents' use of the monitors and also their opinions about iHospital's significance for working procedures, productivity and quality are clarified.

The questionnaire covered a total of 411 people corresponding to all employees at Horsens Regional Hospital, who use iHospital in their daily work. A total of 238 completed forms were returned, which gives a response rate of 58 %. No blank forms were returned.

Table 9.1 Who responded? - Grouping of respondents in departments

Department	Number (response rate)	Sample percentage share
Surgical ward	31 (66 %)	13
Ward (P4, P5, P6)	126 (56 %)	53
Central sterilisation department	11 (58 %)	5
Anaesthetics department	40 (64 %)	17
Recovery ward	11 (22 %)	4
Service / other	19	8
Total	238 (58 %)	100

Table 9.1 indicates the division of respondents divided in hospital departments. The table shows that the questionnaire's representativity is good. The response rate is generally high for the surgical ward, anaesthetics department, the wards and the central sterilisation department, while the participation in the recovery ward was lower.

The respondents were asked to state their age, gender, seniority and occupation. The average respondent is 39.5 years old (mean value 39.5 yeas and standard deviation 14.3 years), female (84 % of the respondents are female) and has been employed at Horsens Regional Hospital for well over 11 years (mean value 10.6 years and standard deviation 16.7 years). The respondents are distributed among occupation categories in the following manner: Nurses 56.3 % (including nurse anaesthetists 9.7 % and recovery ward nurse 2.1 %), surgeon 18.9 % (hereof orthopaedic surgeon 8.8 % and gynaecological surgeon 3.8 %), other 24.8 % (hereof healthcare assistant 8.8 %, anaesthesiologist 2.5 %, other surgery personnel 4.3 %, service staff 1.7 %, employed in the central sterilisation department 1.7 % and other 5.8 %).

_____

The respondents were asked how they had learned to use iHospital. The majority of the respondents stated that they have learned it from colleagues (71.9 %) and/or learning by doing (57.6 %).

A total of 16.4 % had received planned education and 12.6 % had learned it from people from the IT company. Only 5 % stated that they had read the user guide/manual.

Some of the staff members have a coordinator role defined as surgery coordinator, board responsible or a coordinating role within anaesthesia on the nursing- or surgeon aspect. A total of 53 respondents (22 %) state that they have one of these coordinator roles, 179 (75 %) have no coordinator role and 6 (3 %) are unanswered.

Finally, the respondents were asked to state which departments they are in contact with in their daily work. The division of responses according to the number of department contacts is that 102 (43 %) have contact with five or more different departments in the hospital on a daily basis. The other 135 respondents (57 %) state being in contact with one to four departments.

Use of monitors

One of the central objectives of the questionnaire was to cover the staff members' use of iHospital. Therefore, the respondents have been asked to answer how often they use the monitors from iHospital for different purposes. Table 9.2 below shows the grouping of all respondents regarding the frequency of the use of the monitors.

Table 9.2 How often are the monitors used? - The division of all respondents in percentages

Use of monitor in order to:	How frequent (%)				
	More than 10 times daily	5-10 times daily	1-4 times daily	Infrequent / never	Not indicated
Look at the surgical programme	16	32	37	13	2
Change the surgical programme	1	3	14	72	10
Register patient status	3	9	27	52	9
Send messages / chat	2	7	37	48	6
Update status arrow	7	6	9	67	11
Look at the video image	6	11	14	59	10
See which team I am to work with/in	1	3	16	70	10

The table shows that among staff members there are a considerable visual (or passive) use of the monitors, because 16 % look at the surgical programme more than ten times a day, 32 % between five to ten times and 37 % between one to four times a day. A significant effect of iHospital is that staff members have the opportunity to get overview of the daily surgical programme (and ongoing changes in this) by looking at the monitors. In addition to this, it is seen that many

of the respondents only rarely/never use the monitors to, for instance, make changes in the surgical programme, register patient statusor update status arrow. This is because these roles are delegated to a few individuals. Finally, the table shows a considerable tendency of not answering, which varies according to activity, because only two percent (five respondents) have refrained from answering regarding use of the monitors to look at surgical programme, while 11 percent (26 respondents) have not replied concerning the use of monitor to update status arrow. This is probably because of many respondents do not respond to questions irrelevant to their tasks. In an independent analysis of unanswered forms (data not shown), we found significant variations between the departments. For instance, a much larger share of the respondents from the central sterilisation department and the service department did not answer the questions about looking at team and report patient status, because these are irrelevant questions to these staff member groups.

Table 9.3 below shows who are using the monitors often (that is, five times or more a day). The table gives a chi-square test of the differences between the departments. A star at the calculated 'test statistic' indicates a significant difference between the department's use of the monitors. Notable department variations are seen in most usages, because the surgical ward is generally high, however exceeded by recovery ward with regard to registration of patient status. Again, the high passive use of the monitors for surgical ward, anaesthetics department and recovery ward is seen. The chat function is primarily seen as being used by the surgical ward, which explains the generally low degree of usability of the hospital as a whole cf. table 9.2. Apparently, changes in the surgical programme occur so infrequently that department variations of importance have not been registered on this issue. Registration of patient status is primarily the role of the recovery ward. Some departments stand out by selective use of monitors; the anaesthetics department has a clear tendency towards that the monitors primarily are used to monitor the surgical programme and look at video image.

Table 9.3 Who use the monitors frequently (five times or more a day)?
The division per department in percentages (unspecified are omitted).

	Frequently uses monitor in order to (%):						
	Look at surgical programme	Change surgery status	Register patient status	Message / chat	Update status arrow	Look at video image	Look at team
Surgical ward	87	3	29	48	75	53	9
Ward	40	5	6	3	1	4	0
Central sterilisation department	27	0	0	0	0	0	0
Anaesthetics department	60	5	10	7	5	46	10
Recovery ward	45	0	54	0	36	9	0
Service / other	17	0	14	0	6	0	0
Chi-square	32.21***	2.10	29.80***	65.51***	115.25***	66.44***	14.70**

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

In order to elaborate on the analysis of who uses the monitors frequently, it has been studied if coordinators and individuals with frequent contacts with other departments use the monitors to a greater extent. Table 9.4 illustrates that coordinators to a notable higher extent than non-coordinators are heavy users of the monitors to look at surgical programme and video image.

Table 9.4 Is it mostly the coordinator who frequently use the monitors?
Percentage who frequently uses monitor (five times or more daily) (unspecified are omitted).

	Frequently uses monitor in order to (%):						
	Look at surgical program-me	*Change surgery status*	*Register patient status*	*Message / chat*	*Update status arrow*	*Look at video image*	*Look at team*
Non-coordinator	39	3	12	7	13	10	2
Coordinator	79	5	17	18	20	42	8
Chi-square	25.90***	0.31	0.62	5.94**	1.81	25.25***	3.78*

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

The share of respondents, whofrequently use the monitor for message and chat, is not particularly large, but the share for coordinators is more than twice as big as of non-coordinators. A similar picture is seen for frequent use to look at team. In the other aspects, the share of heavy users among coordinators is not notably higher than among non-coordinators.

A similar picture is in evidence when looking at the significance of the number of daily contacts to other departments on the use of iHospital. Table 9.5 illustrates that considerable larger parts of respondents with many contacts are heavy users of monitors. This applies to most of the uses, however excluded the use of the monitors to make changes in the surgical programme and the use to look at team.

Table 9.5 Is it mostly staff members with many contacts, who frequently use the monitors?
Percentage who frequently uses monitor (five times or more daily) (unspecified are omitted).

	Frequently uses monitor in order to (%):						
	Look at surgical pro-gramme	*Change surgery status*	*Register patient status*	*Mes-sage / chat*	*Update status arrow*	*Look at video image*	*See team*
One to four contacts	41	4	8	4	6	9	2
Five or more contacts	56	4	20	17	26	32	5
Chi-square	5.37**	0.01	5.19**	8.88***	16.59***	16.88***	2.26

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

However, the reported differences are dependent on where the boundary between few and many contacts is placed. If the boundary is defined as two, three, four or more, the differences would

_____

have been considerably less significant. If the boundary is defined as five, six or more, the same results are by and large achieved. This seems to suggest that hospital staff members can manage one to four contacts without significant problems, whereas it gets complicated at five or more contacts. Interactive tools are from this level experienced as an additional help. This could suggest that hospital employees with many contacts to a greater extent than employees with few contacts experience iHospital as an additional help and relief in correlation with the management of concrete daily tasks.

Changes in working procedures

The respondents were asked about their opinion on iHospital's significance to the daily work. Table 9.6 below shows the division of respondents according to agreement of the significance of iHospital.

Table 9.6 Has the implementation of iHospital caused changes in the daily work?
The division of all respondents in percentages

	Response (%)				
Implementation of ihosptial has caused:	Agree	Either / or	Disagree	Do not know	Unanswered
- fewer interruptions	31	33	14	20	2
- better overview	64	19	7	8	2
- steps saved	35	39	13	11	2
- easier access to information	57	24	8	9	2
Better information to patients / relatives	34	28	20	16	2
- more efficient work	31	42	13	12	2
- extra work	9	32	43	14	2

Overall, the table illustrates that more agree than disagree that iHospital has had a positive effect in the daily work, defined as fewer interruptions, better overview, saved steps, easier access to information, better information to patients/relatives and/or more efficient work. Between 31 % and 64 % agree on this while 7 % to 20 % disagree. A relatively large group of between 19 % and 42 % are neutral. Only around 2 % (between four and five respondents) have not answered the questions.

There are especially a high level of agreement concerning that the implementation of iHospital has lead to better overview and easier access to information. On these questions, there is also biggest clarity about the effect, because fewer than 10 % of the respondents did not know what they were to answer to these questions. Moreover, there was the smallest share of neutrals (that is, either/or respondents) to these questions. A relatively few number of respondents believe that iHospital has caused a bigger workload. This is primarily employees from the recovery ward,

where extra tasks have occurred in connection with the registration of patient status, when the patient arrives at the recovery ward and when the patient is ready to be brought to the ward (see table 9.7).

The biggest degree of disagreement is expressesed concerning the effect of iHospital on information to patients and relatives; here, about 20 % of the respondents consider iHospital as having had no effect. According to the below mentioned, this can be explained by department-specific differences, because the question is primarily relevant for departments with frequent contact with patients/relatives. Greatest obscurity about the effect of the the implementation of iHospital is apparently concerning number of cancellations. Around 20 % did not know what to answer. If the 33 % who were neutral is added to this, then it says that over half of the respondents do not have an unambiguous opinion about this issue.

Table 9.7 shows who particularly thinks that iHospital has caused changes in the daily work. For instance, 65 % of the respondents from the surgical ward believe that iHospital has caused fewer interruptions in the daily work. The remaining 35 %, who are not mentioned in the table, either disagree, are neutral or do not know.

Table 9.7 Who thinks iHospital has caused changes in the daily work?
Percentage per department who agrees with the statement (unspecified are omitted).

	Implementation of ihosptial has caused (%):						
	Fewer interruptions	*Better overview*	*Steps saved*	*Easier access to information*	*Extra work*	*Better information to patients / relatives*	*More efficient work*
Surgical ward	65	87	76	70	12	22	38
Ward	22	56	24	53	9	45	23
Central sterilisation department	46	81	54	72	0	0	72
Anaesthetics department	38	74	50	55	5	10	45
Recovery ward	18	72	18	72	27	55	18
Service / other	18	41	5	52	11	52	23
Chi-square	15.16***	17.85***	42.65***	5.37	6.70	27.68***	17.82***

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

Table 9.7 shows that for most of the questions, there is considerable variation across departments in how many agree with the statement. This is reflected in the very significant chi-square values. Concerning the statement that the implementation of iHospital has caused fewer interruptions, the surgical ward scores very high, given that 65 % of the respondents agree that iHospital has had this effect while only 18 % agreement in the recovery ward and service/other. Concerning better overview, considerable department differences is also perceived. The surgical ward is at the top with 87 % agreement, followed closely by the central sterilisation department

with 81 %, while less than half are in agreement in the service/other department. For easier access to information it is seen from the chi-square statistics that there are not significant differences between departments, because there are fairly large percentages in all departments who agree. The recovery ward is seen as being relatively high concerning extra work, but because it is a relatively small department with only 11 respondents (4 % of the spot check), it does not occupy much space in the big picture. Consequently, the chi-square statistics does not state significance of the discovered department differences on this point.

Table 9.8 shows that attitudes toward iHospital's influence on the daily work depends on whether or not the staff members have a coordinator role.

Table 9.8 Is it mostly the coordinators, who experience that iHospital has caused changes in the daily work? Percentage who agrees with the statement (informed are omitted).

	Implementation of ihosptial has caused (%):						
	Fewer interruptions	Better overview	Steps saved	Easier access to information	Extra work	Better information to patients / relatives	More efficient work
Non-coordinator	27	62	28	57	10	37	29
Coordinator	45	76	61	62	5	28	41
Chi-square	6.00**	3.71*	19.12***	0.34	0.97	1.64	2.85*

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

Table 9.8 shows that the most significant difference on coordinators and non-coordinators is with regard to steps saved. Almost two thirds of the coordinators agree on this effect of iHospital, while less than a third of the non-coordinators see this effect. Moreover, almost half of the individuals with a coordinator role think that iHospital has lead to fewer interruptions, while a little more than a quarter of the non-coordinators have experienced this effect. Both groups are to a great extent in agreement that iHospital has caused a better overview, even though the share of this opinion is slightly larger among coordinators. Furthermore, there is a great extent of agreement that iHospital has provided easier access to information; the difference between coordinator and non-coordinator is minor and not statistically significant. It is seen that coordinators to a greater extent than non-coordinators find that more efficient work can be done with iHospital. Finally, the figures show that non-coordinators to a greater extent than coordinators experience that iHospital has caused extra work. However, the difference is not statistically significant because the share is relatively small for both groups – only 10 % of non-coordinators and 5 % of coordinators feel additionally burdened by iHospital.

It was studied if the attitudes/opinions about changes in the daily work because of iHospital could be a result of having many daily connections with other departments.

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Table 9.9 Is it mostly staff members with many contacts who experience that iHospital has caused changes in the daily work?
Percentage who agree with the statement (unspecified are omitted).

	Implementation of ihosptial has caused (%):						
	Fewer inter-ruptions	*Better overview*	*Steps saved*	*Easier access to in-formation*	*Extra work*	*Better in-formation to patients / relatives*	*More effi-cient work*
One to four con-tacts	28	60	31	59	8	38	30
Five or more contacts	35	70	40	56	11	31	34
Chi-square	1.41	2.58*	2.03	0.11	0.38	1.16	0.60

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

The table shows that a slightly larger share of respondents with many contacts find that the use of iHospital has lead to a better overview. In addition, there are no significant differences in the respondents with few and respondents with many contacts. The results are quite strong, because consistent results were by and large achieved independently from where the boundary between few and many contacts was placed. In this way, the number of contacts has not influenced the attitudes towards changed working procedures in connection with the implementation of iHospital in a degree worth mentioning.

Changes in communication

The respondents were asked about their opinion on iHospital's significance on the communication in the hospital. Table 9.10 below shows the division of respondents according to agreement of the significance of iHospital.

Table 9.10 Has the implementation of iHospital caused changes in the communication in the hospital? The division of all respondents in percentages.

	Response (%)				
Implementation of iHosptial has caused:	Agree	Either / or	Dis-agree	Do not know	Unan-swered
- easier contact with personnel	41	32	11	14	2
- easier coordination	42	31	7	18	2
-easier management of changes	52	20	12	14	2
- easier communication with personnel	48	26	10	15	1
- better communication between de-partments	39	32	9	19	1
- the hospital is brought closer together	30	37	7	24	2

Generally seen, table 9.10 shows that more agree than disagree that iHospital has had a positive effect on communication between staff members and with other departments, coordination and management of changes in the daily surgical programme and possibilities to connect with relevant personnel in the hospital. Between 30 % and 52 % agree on this while only between 7 % and 12 % disagree. The neutral group constitutes between 20 % and 37 %, and only 1-2 % are unanswered. There is a high extent of agreement that iHospital has resulted in an easier management of changes in the daily surgical programme, and also that is has become easier to communicate with relevant personnel in the hospital.

Table 9.11 shows who particularly thinks that iHospital has brought improvements of the communication in the hospital.

Table 9.11 Who thinks that iHospital has caused changes in the communication in the hospital?
Percentage per department who agrees with the statement (unspecified are omitted).

	Implementation of iHosptial has caused (%):					
	Easier connection	*Easier co-ordination*	*Easier to handle changes*	*Easier communicaiton*	*Better communication between departments*	*The hospital brought closer together*
Surgical ward	58	48	77	70	54	35
Ward	41	40	43	44	37	29
Central sterilisation department	55	55	63	54	54	36
Anaesthetics department	41	52	66	50	35	25
Recovery ward	27	36	72	36	18	40
Service / other	17	29	29	35	35	29
Chi-square	9.17*	4.53	21.21***	9.14*	6.79	1.66

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

Table 9.11 shows that department variations regarding shares who declare in agreement with the statements, in general – cf. the chi-square statistics - are modest and/or uncertain. However, one single notable statement is 'easier to handle changes'; here, the surgical ward, the recovery ward, the anaesthetics department and the central sterilisation department stand out because a large number agrees while in service/other and ward there are relatively few who agree.

Table 9.12 shows if attitudes and perceptions of iHospital's influence on the communication in the hospital depend on whether or not the respondents have a coordinator role.

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Table 9.12 Is it mostly the coordinators who experience that iHospital has caused changes in the communication in the hospital?
Percentage who agrees with the statement (unspecified are omitted).

	Implementation of iHosptial has caused (%):					
	Easier connection	*Easier co-ordination*	*Easier to handle changes*	*Easier com-municaiton*	*Better commu-nication be-tween depart-ments*	*The hos-pital brought closer to-gether*
Non-coordinator	39	37	46	46	35	26
Coordinator	51	60	76	56	52	41
Chi-square	2.66*	8.70***	15.11***	1.82	5.29**	4.50**

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

The most significant difference is that coordinators find it easier to handle changes after the implementation of iHospital to a much greater extent than non-coordinators. Furthermore, it is seen that coordinators find that iHospital has lead to easier coordination, better communication between departments and a hospital tied closer together to a significantly greater extent than non-coordinators, and also that coordinators experience to a slightly higher extent that contact between colleagues have become easier. More coordinators than non-coordinators find that the communication has become easier; however, the difference is not statistically significant.

It has been studied if opinions/perceptions of iHospital's influence on the communication in the hospital depend on the number of daily contacts to other departments cf. table 9.13.

Table 9.13 Is it mostly staff members with many contacts who experience that iHospital has caused changes in the communication in the hospital?
Percentage who agrees with the statement (unspecified are omitted).

	Implementation of iHosptial has caused (%):					
	Easier connec-tion	*Easier coordi-nation*	*Easier to handle changes*	*Easier com-municaiton*	*Better commu-nication be-tween depart-ments*	*The hospital brought closer to-gether*
One to four contacts	41	39	49	47	34	25
Five or more contacts	43	46	58	50	46	37
Chi-square	0.11	0.91	1.60	0.16	3.18*	4.08**

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

In general, a larger share of respondents with many contacts seems to agree with the utility of iHospital. However, the differences are mainly modest; a significant difference has only been found with regard to agreement with that the hospital is brought closer together. Furthermore, there is a slightly significant difference in the perception that the communication between the departments has improved. The results were, cf. the discussion above, also strong facing the choice of border between few and many contacts.

Productivity and quality

Finally, the respondents were asked about their attitudes towards/perceptions of changes in productivity and quality as a result of iHospital. Table 9.14 illustrates the division of respondents according to reply to questions concerning productivity and quality (understood as risk of unintended events).

Table 9.14 Has the implementation of iHospital caused changes in productivity and quality? The division of all respondents in percentages.

	Response (%)				
	Agree	Either / or	Disagree	Do not know	Unan-swered
iHospital has increased the productivity	11	30	18	40	1
Good idea to implement iHospital on larger hospitals	64	3	9	23	1
iHospital has produced better utilisation of the time in the operating room	29	17	12	41	1
iHospital reduces the risk of unintended events	21	18	20	40	1

Table 9.14 shows that rather large shares of the respondents do not know. Only 11 % think that iHospital has produced an increased level of productivity. However, this should be read with caution because the interview survey has illustrated that different perceptions of the word 'productivity' may exist. Several interviewees think that productivity is only a question about getting more patients through the system, which is a misunderstanding of the concept, because it is not an input/output relationship. Besides, it should be observed that the management cf. an interview with the chief physician, has intentionally avoided linking a wish for increased productivity together with the implementation of iHospital. Tt should also be noticed that 29 % believe that iHospital has caused a better utilisation of the time in the operating room, which if anything can be read as an expression of increased productivity. Furthermore, it should be seen in the light that a series of respondents do not work in the surgical ward on a daily basis (e.g. nurses in the wards) and have probably replied 'do not know' to this question.

Table 9.14 shows that 64 % believe that it would be a good idea to implement iHospital on all larger hospitals in Denmark. However, it is unclear what specifically lies behind this broad recommendation.

Regarding the question of whether iHospital has reduced the risk of unintended events, the conducted interviews have shown that the concept of 'unintended events' is able to cover different aspects depending on where in the hospital you are working. In the surgical ward, unintended events will often be linked together with risks in the patient treatment, while in the central sterilisation department, for instance, they would also link the concept to delivery of wrong instruments, delays and so on.

Table 9.15 shows who thinks that iHospital in particular has significance for productivity and quality.

Table 9.15 Who thinks that iHospital had caused changes in productivity and quality? Percentage per department who agrees with the statement (unspecified are omitted).

	iHospital has increased the productivity	*iHospital is a good idea in larger hospitals*	*iHospital has lead to better utilisation of the time in the operating room*	*iHospital has reduced the risk of unintended events*
Surgical ward	19	83	38	36
Ward	7	58	24	16
Central sterilisation department	36	81	30	63
Anaesthetics department	7	65	47	15
Recovery ward	27	72	9	9
Service / other	5	58	17	17
Chi-square	15.13***	8.83	12.75**	19.78***

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

In the table it is seen that especially respondents from the surgical ward, anaesthetics department, recovery ward and central sterilisation department express positive attitudes towards iHospital's influence on productivity and quality. 83 % in the surgical ward, 81 % in the central sterilisation department and 72 % in the recovery ward generally recommend the implementation of iHospital in other hospitals. 47 % in the anaesthetics department and 38 % in the surgical ward agree that iHospital has lead to better utilisation of the time in the operating rooms. 63 % in the central sterilisation department believe that the risk of unintended events is reduced.

Table 9.16 shows if attitudes/perceptions of importance to productivity and quality depend on whether the respondents have a coordinator role.

Table 9.16 Is it mostly the coordinators, who experience that iHospital has caused changes in productivity and quality? Percentage who agrees with the statement (unspecified are omitted).

	iHospital has increased the productivity	*iHospital is a good idea in larger hospitals*	*iHospital has lead to better utilisation of the time in the operating room*	*iHospital has reduced the risk of unintended events*
Non-coordinator	11	66	25	20
Coordinator	9	64	39	23
Chi-square	0.24	0.09	3.92**	0.18

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

The table shows that coordinators to a considerably greater extent than non-coordinators find that iHospital has lead to better utilisation of the time in the operating rooms. About two thirds of the respondents think that it would be a good idea to implement iHospital in other hospitals; here, there are no differences in the two groups. Just under a quarter of the respondents think that iHospital may reduce the risk of unintended events, and the two groups are not different

from one another in this evaluation. Given that unintended events probably were a central focus area also before iHospital, this number must be seen as an expression of a significant gain with iHospital. Around one tenth of the respondents have experienced increased productivity as a result of iHospital. It is remarkable that the share is slightly – although not statistically significant – larger for non-coordinators. This could indicate a considerable heterogeneity in the understanding of what an 'increase in productivity' actually is; some have probably experienced it as a negative concept, while others have experienced it as a positive concept.

Table 9.17 shows if the number of contacts to other departments has an impact on opinions/perceptions of iHospital's importance for productivity and quality.

Table 9.17 Is it mostly staff members with many contacts who experience that iHospital has caused changes in productivity and quality?
Percentage who agrees with the statement (unspecified are omitted).

	iHospital has increased the productivity	*iHospital is a good idea in larger hospitals*	*iHospital has lead to better utilisation of the time in the operating room*	*iHospital has reduced the risk of unintended events*
One to four contacts	9	64	23	21
Five or more contacts	12	65	36	20
Chi-square	0.51	0.02	4.65**	0.01

Significant differences in replies are marked at chi-square with *** (1 %), ** (5%), * (10 %).

A significantly large share of respondents with many contacts considers that iHospital has lead to better utilisation of the time in the operating rooms. Cf. table 9.17 there is probably correlation between people with many contacts and people with a coordinator role. For the other questions, there is no noticeable effect if one has few or many contacts. Cf. the discussion above the results are strong facing where the border between few or many contacts is placed.

Appendix 10:

Evaluation of unintended events

Material: All incidents in which the department is indicated as the anaesthetics department, Horsens Regional Hospital (the anaesthetics department has the responsibility for the surgical ward at Horsens Regional Hospital) that were reported to the Danish Patient Security Database in the period 18 May 2004 to October 2008. are included in this study This concerns a total of 207 cases which have occurred in the day surgery ward and the central surgical ward.

Method: All incidents have been printed as they were when they were reported in the database, that is, without the subsequent handling of cases. Afterwards, the quality coordinator and a head nurse from the surgical ward went through all cases one by one.

Result: Eight events were considered to could have been potentially avoided if iHospital had been implemented. No incidents of which circumstances about or use of iHospital were deemed to have a contributing cause to the incident were reported. The identified incidents are examined in the summary below.

Episode A: At the lunch break, the operating room staff were to be relieved, and the two personnel teams did not communicate properly about the patient who was about to undergo surgery. After the surgery, it was found out that no staff members had spoken to the patient before he/she was anaesthetised. 'To speak with the patient' means telling about the anaesthesia, the surgery and to ask the patient if there are any special circumstances that the staff members should be aware about before they begin the surgery.

How could iHospital have helped: When the patient is reported ready in iHospital, all procedures have been gone over with the patient. That is, that you do not place a 'ready status' before all postoperative procedures are gone through. The leaving personnel team would not have placed a 'ready status' on the patient, and therefore the replacing personnel team would be able to see that procedures had not yet been gone through and could ask about these. At Horsens Regional Hospital there has recently been made a clear definition of what is to be done before a patient can be reported ready.

Episode B: At one point in time a telepathological room was established at Horsens Regional Hospital. In this room, the personnel had a telephone connection with department of pathology at Vejle Hospital. In this episode, a surgery took place in another operating room than the one with equipment for telepathology. After the surgery, there was a need to use the telepathological connection and the medicament from the surgery was brought to the room where the telepathological equipment was located. In this room another patient was in surgery. A label which were to be placed on the medicament brought along, was left in the room and was subsequently placed on a medicament for the other patient who was having surgery in room in question (that is, a wrong patient label on a medicament that was subsequently to be brought to examination).

How could iHospital have helped: By means of a better overview with iHospital, the surgical programme could have been planned better, so the patient with the need for the telepathological connection had from the start been placed in the telepathological room.

Episode C: A surgeon reported in sick. This message was not passed along to the surgical ward in the morning. This resulted in an operation being cancelled in the last part of the daily surgical programme.

How could iHospital have helped: With iHospital, the surgeons would already at the morning conference be able to pass on the message to the surgical ward by means of the chat function in iHospital. Then the surgical ward had had the opportunity to get hold of another surgeon or in some other way rearrange the surgical programme.

Episode D: An acute patient was brought in on a weekend. All operating rooms were full, and the surgeon judged that the patient was able to wait for surgery till early on the next day. The patient was, however, not operated until late the next day. In addition, there was waiting time on instruments for the surgery because the central sterilisation department did not have the possibility to be aware of acute patients.

How could iHospital have helped: The overview which iHospital provides could perhaps have provided a better planning in order for the patient to have gotten on the surgical programme earlier. iHospital delivers a better overview of the complex composition of patients.

Episode E: During an evening shift, a patient who was not on the planned surgical programme arrived. The patient was put on the surgical programme as the first patient on the following day. The patient was already brought to the operating room when staff members entered the room. The surgery which was originally planned was the same kind of procedure as the acute patient, and the patients had almost similar first names. Not until after the actual procedure do the staff members discover that they were dealing with another patient than the one they thought.

How could iHospital have helped: By the use of iHospital, the staff members would have updated the surgical programme and added the new patient. When the surgery personnel met in the operating room the subsequent day, the new and updated surgical programme would have been visible to everyone in the room.

Episode F: Patients with insulin demanding diabetes should preferable be put first in the surgical programme, because it is not good for them to fast for too long. In this event, such a patient was placed in the daily surgical programme as the last patient.

How could iHospital have helped: With a better overview from iHospital, perhaps a better planning and distribution of the patients could have been performed.

Episode G: Prior to this episode the surgery team held a timeout before the surgery. Further along in the procedure it was discovered that the surgeon thought that he was operating on another patient than he actually was. The surgeon had spoken with the patient prior to the surgery without noticing that the patient stated another name than what the surgical programme said. Subsequently, it was discovered that the staff members from the evening shift had switched the first and second patient in the surgical programme. The patients had the same gender and were to undergo the same operating procedure.

How could iHospital have helped: With iHospital it is clearer who is to undergo surgery. The surgeons can see it in the coordinator central and in the actual operating room. And they will always have the updated surgical programme at their disposal.

Episode H: A patient was experiencing postoperative pain and needed to be prescribed some analgesic medicine. The outcome was that the patient was prescribed some analgesic medicine, which the patient had already had during the actual surgery.

How could iHospital have helped: The possibility to see the monitor several places in the hospital gives the physician a better possibility to see the patient on a monitor, while he is talking to

those who request the medicine. Hereby, the physician can get a better overview of what is happening during the actual surgical procedure and what medicine is prescribed during the surgery. This case is a matter of inadequate communication.