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Requirements Elicitation On Integrating Clinical Guidelines To Electronic Patient Record: An Empirical Study

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ABSTRACT

There is little research on the requirements elicitation of integrating of clinical guidelines and electronic patient record while in this master project I managed to use different methods to collect and elicit requirements on this field.

[Methods] Firstly, I did paper study on the relevant topics about requirements elicitation of clinical guideline integration and further an experiment and follow-up survey was designed to (1) identify the importance and necessity of navigating and searching in clinical guideline and (2) elicit relevant requirements to improve the use of clinical guideline and the integration. **[Discussion]** Through analyzing the data, we found that providing the recommendation lists can improve the speed of scanning the guideline; the structure and searching function of clinical guideline had shape the usage of clinical guideline.

[Conclusion] The findings show that clinical guideline structure and the recommendation format are important factors that could affect the performance of clinicians searching and decision making. Therefore, to successfully provide guidelines support into patient record and enhance the searching function, guidelines should be computerized in a more searching friendly and structured way, also rather than isolated from the patient data.

Keywords

Clinical guideline, decision support, requirements elicitation, experimental design

PREFACE

This master thesis was written for my master degree at Norwegian University of Science and Technology (NTNU). The master project was carried out under the supervision of professor Øystein Nytrø as a part of preliminary study of Evicare project.

Firstly, I would like to thank my supervisor Øystein Nytrø for his guidance and suggestions during the whole project. He is always there for my questions and confusion and has shown me to the right direction. And I would offer my appreciation also to associate professor Laura Slaughter for her advises and effort to help me build the experiment.

Secondly, I want to thank master student Terje Røsand for his kind help within the whole experiment. We shared and executed the same experiment with different goals, but with his help everything went smoothly. And also the discussion between us has given me inspiration. Additionally, I would thank DIPS ASA together with master student Trond Elde as for their help for providing me of their interface prototype.

At last, I will thank my friend and family who always support me and give me endless help.

ACRONYMS

RE Requirements Engineering

CDSS Clinical decision support systems

EHR Electronic health record

DIPS ASA the largest supplier of electronic patient record systems to Norwegian hospitals.

IDI Institutt for datateknikk og informasjonsvitenskap (Department of Computer and Information Science)

NTNU Norges teknisk-naturvitenskapelige universitet (Norwegian University of Science and Technology)

GP General Practitioner

Content

CHAPTER 1

INTRODUCTION

The first chapter gives a general overview of the master project by introducing the whole work of the project, the motivation behind the project and the research questions.

1.1 PROJECT DESCRIPTION

Clinical guideline is important during the whole clinical decision making process. The purpose of guidelines [1] is to improve the quality of care for patients and improve clinical effectiveness by implementation of evidence-based care in daily practice.

However, clinical guidelines do not get the maximized effect during the clinical care process. There are many factors that affect the use and implementation of clinical guidelines and the requirements for integrating clinical guidelines with clinical care needs more research.

While in my project, I was going to study some factors that could affect the use of clinical guideline and elicit requirements on how to integrate clinical guidelines with EHR to provide decision support.

We had designed a randomized experiment to extend what we have done last semester, to imitate the clinical situation, asks the clinician to complete several tasks according to a real case and using forms, questionnaire to collect data. The experiment studied the interaction between the clinician and guidelines, which includes the clinician's searching behavior towards clinical guidelines and the impact of guidelines structure on clinicians' decisions. The data was analyzed for requirements elicitation after the experiment to answer our research questions.

Based on the experiment, I listed some important factors that affect the use of guidelines, we can design clear structured clinical guidelines and searching system thus integrates them into clinical practice.

1.2 RESEARCH MOTIVATION

The aim of clinical guidelines is to improve quality of care by translating new research findings into practice. Having found and appraised a guideline, users may find it valuable to know whether there are additional attributes that make the guideline more likely to be used. There is evidence that the following characteristics contribute to their use: inclusion of specific recommendations, sufficient supporting evidence, a clear structure and an attractive layout [2]. The clear structure and searching friendly feature of clinical guideline would decrease the searching time within the guideline and increase the working efficiency.

However, whether the presentation of clinical guideline has what impact on clinician's searching behavior and what is clinician's opinion towards the use of clinical guideline, how the clinical guideline should integrate into EHR still lack relevant research and findings. Hence more study and methods should be designed to evaluate these research questions.

Last semester we have done a pilot experiment to elicit clinician's clinical questions in a small scale. And we gained some knowledge of designing case-based experiment, thus based on the previous experiment, with the goal of studying and eliciting requirements related to guidelines presentation, this time we decided to carry out a larger scale experiment which incline to evaluate the interaction between clinicians and guidelines, learn how the structure and searching function or other attributes of clinical guideline shape the clinician's searching behavior.

This is a pre study for finding new theory and requirements in the areas of guideline representation and integration with EHR, evidence-based practice.

1.3 GOALS AND RESEARCH QUESTIONS

This project has three goals to research; in order to elicit preliminary requirements for computerized clinical guideline with electronic patient record system:

The first objective is to identify the existing representations and interfaces of clinical guidelines. Study the structure and format of clinical guidelines and recommendations in specific guideline.

The second objective is to evaluate and test clinical guideline structure (representations and interface). Try to see if the clinical guideline provides useful and quick answers to clinical questions. And in addition we will study the communication modes between clinicians and clinical guidelines.

The third goal is to based on the empirical study; elicit the requirements for integration of clinical guidelines with electronic patient record in decision support systems.

Research questions:

1. What is the presentation format of clinical guidelines?

2. Do clinical guidelines provide useful and quick answers to clinician's clinical questions?

3. Do clinical guideline structure affect its usage and efficiency?

4. How do clinicians think of searching function and how should we improve searching function in clinical guideline?

5. What are the possible solutions and requirements for integrating clinical guidelines with EHR?

1.4 CONTEXT AND OUTLINE

The following part of this paper contains:

Preliminary study: Review of relevant papers concern to the evaluation of clinical guidelines, clinical questions and clinical decision support systems. And how these theories inspire my study and contribute to our design.

Research Method: The presentation of research methods and process.

Experiment preparation: This chapter gives the general information of the experiment management, by figuring out the different stakeholders.

Experimental design: Detailed content of how the randomized experiment was designed and executed and the evaluation and discussion of result. In the end we have some conclusion of the project and future work.

Conclusion and Future work: This will be the conclusion of the experiment, as well as the summary of this project, what I have learned from the whole process and design.

CHAPTER 2

PRELIMINARY STUDIES

This chapter introduces the basic theory and knowledge behind the master project. Here I started with the basic knowledge of requirements engineering and its use in clinical field. Then I did some study on clinician's searching behavior and clinical questions, after that there would be a detail explanation of clinical guidelines and its different presentation format as well as its usage.

2.1 REQUIREMENTS ENGINEERING

Requirements Engineering (RE) is a set of activities concerned with identifying and communicating the purpose of a software-intensive system, and the contexts in which it will be used. Hence, RE acts as the bridge between the real-world needs of users, customers, and other constituencies affected by a software system, and the capabilities and opportunities afforded by software-intensive technologies [3].

Requirements engineering is important in system design, studies of general software development projects [4] have shown that investments in requirements analyses significantly reduce systems maintenance costs.

Requirements elicitation is the first step in the requirements engineering process. The word "elicitation" means that simply asking the right questions cannot collect requirements [5]. One important goal of elicitation is to find out what problem needs to be solved. Information gathered during requirements elicitation often has to be interpreted, analyzed, modeled and validated [6]. There are various ways to elicit requirements, while analyst should consider the goals of different stakeholders as well as the essence of the domain knowledge.

RE IN CLINICAL FIELD

Requirements engineering could be considered as the most critical and important area of the whole system design. The right requirements can generate the right system, which could efficiently help to achieve the goals of different stakeholders.

In addition, clinical field is a special field that requires systems have the features as high accuracy and time saving. Therefore information systems in clinical field are more critical and high-risk system that requirements engineering should be more emphasized to assure these qualities.

USER-CENTERED DESIGN

As we know, requirements usually start from the usage world of user. User requirements are considered right from the beginning and included into the whole product cycle.

Clinicians are the user of clinical guideline and clinical decision support system; therefore they should be put in the center of the design and implementation process. Successful guideline implementation strategies should be multifaceted, and actively engage clinicians throughout the whole process [7].

2.2 CLINICIAN'S SEARCHING BEHAVIOR AND QUESTIONS

CLINICIAN'S SEARCHING BEHAVIOR AND SOURCES

Clinicians always have questions when they are in the care process of patient. But while searching engines have become nearly ubiquitous on the Web, electronic health records (EHR) generally lack search functionality [8].

Natarajan, Karthik et el [9] analyzed user search log files for 6 months from an EHR-based, free-text search utility at an academic institution and found variety of user types, ranging from clinicians to administrative staff, took advantage of the EHR-based search utility. Though these users' search behavior differed, they predominantly performed informational searches related to laboratory results and specific diseases. Another study Shariff , Salimah Z [10] did on preferences of nephrologists in Canada for 2 years found that nephrologists routinely used a variety of online resources to search for information for patient care. These include bibliographic databases, general search engines and specialized medical resources.

These factors have shown us that searching is an important and essential activity when clinicians are underlying the data of EHR and in the process of patient care. Hence, integrating guideline evidence into EHR with search function is necessary; it can both save time and provide latest information to clinicians.

POSSIBLE SOLUTION TO IMPROVE SEARCHING

There is little research on how to improve searching function in computerized clinical guideline system. However, if we want to make it useful and applicable to use searching in electronic health record, firstly, a reliable, updated knowledge source for searching is needed. And secondly, we should get clear of clinicians' habit when they are using the guideline and what content from clinical guidelines should be highlighted. By recognizing these key factors, we could come out with realizable solutions to improve searching functionality.

Karen Davies [11] did narrative review of the available literature from the past 10 years (1996–2006) that focus on the information seeking behavior of doctors, he found out that "there are various types of need" among doctors and most of them do not realize there is gap in their knowledge. Therefore, from another point of view, it is desirable to build content aware or auto reminder function in the electronic patient record systems when clinicians are checking the patient record or making decisions.

2.3 CLINICAL GUIDELINES

DEFINITION AND PRESENTATION

Clinical practice guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances [12].

Guidelines have been disseminated in many forms, by lines into the institutional information systems. Academic Press publishes them in magazines and journals, textbooks, CDROMs, and on the Web [13]. These are the traditional presentation formats of clinical guidelines that specified in non-computer interpretable narrative text or non-executable flowchart. These non-computable formats limit the usability of the guideline since the knowledge contained in the guideline may not be easily accessible during the patient encounter [13].

While electronic dissemination has broadened the availability of guidelines, and enables guidelines to be retrieved even in clinical settings [13], computerized clinical guidelines are more popular and appeared in different representation format to integrate with EHR. The translation of paper-based into computer-based guidelines can be done in at least two different ways: 1) in a knowledge based approach an expert extracts information from the guideline text, interprets it, and then encodes it using one of the guideline models; 2) in the document-centric approach mark-up methodologies are used to provide guideline text excerpts relevant to the patient context [21]. Computer-interpretable guidelines (CIGs) that have access to the patient's EPR are able to give personal advice for clinicians [21].

FACTORS AFFECT THE USAGE OF CLINICAL GUIDELINES

Guideline design has great effect on its usefulness among clinicians. But the use in general practice is still limited. Research on barriers to guideline adherence usually focuses on attitudinal factors. Factors linked to the guideline itself are much less studied [14].

When Cabana et al. [15] attempted to review barriers to physician adherence to clinical practice guidelines. They identified seven general categories of barriers affecting knowledge (lack of awareness or lack of familiarity), attitudes (lack of agreement, lack of self efficacy, lack of outcome expectancy, or the inertia of previous practice) or behavior (external barriers, which may be guideline related, patient related or environmental related). Thus it is important to learn how these factors affect the use of clinical guideline and proposes some useful suggestions based on experimental research.

An evaluation [16] on guideline usage finds clarity and presentation significantly influenced the participants' assessment of the guidelines. The developers should ensure that the recommendations are presented clearly and unambiguously, and flowcharts, algorithms and other tools are developed to help the users in applying the recommendations into practice.

Decision support should be provided at the right time and the right place, and the content needs to be reliable. This is precisely why guideline development by both system developer and professionals.

Therefore the clear structure and the presentation format of clinical guidelines are important factors that affect the guideline's usage. The most user friendly

and well-structured clinical guideline with appropriate searching function can be time saving. Also providing specific guideline knowledge for specific patient data could increase the efficient and correct usage of clinical guidelines.

2.4 CLINICAL DECISION SUPPORT SYSTEMS

DEFINITION AND CHARACTERISTICS

Computerized clinical decision support systems (CDSS) are information systems designed to improve clinical decision-making. These systems provide several modes of decision support, including alerts of critical values, reminders of overdue preventive health tasks, advice for drug prescribing, critiques of existing health care orders, and suggestions for various active care issues [17].

The fact that clinical decision support systems has improved clinical performance is already known in many reports, but there are still many factors that affect the use of CDSS.

A review [18] of 68 controlled trials of CDSS (meeting specified criteria) on physician performance and patient outcomes came out with the conclusion that "published studies of CDSSs are increasing rapidly, and their quality is improving. The CDSSs can enhance clinical performance for drug dosing, preventive care, and other aspects of medical care, but not convincingly for diagnosis. "

Another research study on the barriers that affect the use of CDSS [19] finds out that barriers to implementation of CDSS include failure of practitioners to use the CDSS, poor usability or integration into practitioner workflow, or practitioner nonacceptance of computer recommendations.

INTEGRATE CLINICAL GUIDELINES WITH EHRS FOR CDSS

Kawamoto et al. [20] pointed out that successful clinical decision support systems should "(*1*) provide decision support automatically as part of clinician workflow, (*2)* deliver decision support at the time and location of decision making, (3) provide actionable recommendations, and (*4*) use a computer to generate the decision support".

Hence we could see that implementing formalized guidelines in a decision support system with an interface to an electronic patient record (EPR) makes the

application of guidelines more personal and therefore acceptable at the moment of care [21]. This also requires a clinical guideline that has sufficient and actionable recommendations. Developers should be more

In addition, Entwistel M and Shiffman RN [22] pointed out that successful delivery of the knowledge incorporated into guidelines requires a systemic approach, which integrates knowledge with workflow using existing clinical information systems. Electronic clinical decision support systems are the means through which the knowledge embedded in guidelines can be managed and delivered effectively.

From all these data, we can see that when clinical guidelines and EHR tied together can greatly help clinician during work. However, more effort should be put on how to find out the best requirements for these systems and overcome the barriers that lies on the way to integration of different components.

CHAPTER 3

RESEARCH METHOD

This chapter describes the methods that were chosen for my project and in detail how I use and organize the methods.

3.1 RESEARCH METHODOLOGY

It is important to choose the most fitted methods when we are doing research. The right methods can lead us to the right direction and get the best results. The methods should be chosen based on the type of study and what problems researchers are going to solve.

Quantitative research method was originally developed to study natural phenomena in natural sciences and often involves methods such as surveys, laboratory experiments, formal and numerical methods [25]. Qualitative methods were developed in the social sciences to enable researches to study social and cultural phenomena, with methods such as observation, interviews, questionnaires, documents and the researches impressions and reactions [26].

The main difference between quantitative and qualitative research is that qualitative research methods are designed to help researches understand people and the social and cultural context within which they live [27].

My research focused on requirements eliciting, it is a field that require both quantitative and qualitative research to determine the real results and requirements. In another word, it needs to gather certain amount of data as well as to reveal the thoughts and implication behind the behavior of the participants. Hence both qualitative and quantitative methods should be combined together to reach this goal. We choose to use randomized experiment and a follow-up questionnaire to collect data. The reason we choose these methods are demonstrated in the following part.

3.2 REQUIREMENTS ELICITATION TECHNIQUES

There are many ways to elicit requirements, while we can summarize them into the following categories [23]:

- Interview-based methods, including 18 specific types of interviews, each with a different focus (for example, unstructured interviews, interviews to elicit critical success factors, and interviews to construct data-flow diagrams);
- Questionnaires, which are fairly self-explanatory;
- Introspective and observational methods, which elicit information about the users' tasks and values (such as researcher analysis of documentation regarding the task or process being followed, observation of the customer at work, and protocol analysis);
- Contrived techniques, which ask users to engage in some kind of artificial task to help elicit information such as priorities, domain concepts, or goals and subgoals (such as card-sorting and similar strategies for understanding the domain, decomposing goals into finer-grained tasks, or creating hierarchies as in textual laddering).

The method selection should be done according to the understanding of the nature of each method, the problem domain, the organizational context, types of requirements source, etc. [24]. Clinical situations can be very complex in which clinicians have different tasks. Hence contrived and introspective techniques should be used together to engage users doing specific tasks in specific situation while requirements analyst extract data from the observation and documentation.

3.3 DATA COLLECTION

Data collection is the basic action for doing research. With clear and structured data, we could get a deeper view and easily analysis the dat. There are both qualitative and quantitative ways to collect data such as observation, interview, questionnaires, experiments [28], for my project, I chose to use questionnaires and randomized experiment to collect data.

3.3.1 BACKGROUND AND CONTEXT AND REVIEW OF DOCUMENTS

For every qualitative study, data on the background and historical context are gathered. This may not be a major part of data collection but at least, in proposing a particular setting, the researcher gathers demographic data and describes geographic and historical particulars.

In my project, before the participants take part in the experiment, background information were gathered, such as age, gender, previous experience and preference etc. This is to give an overview of their experience and later we can analyze the background context with experiment data to see how their experience had shaped or influenced on their habit or preference when they are using clinical guidelines.

3.3.2 EXPERIMENTAL DESIGN

An experiment is a methodical procedure carried out with the goal of verifying, falsifying, or establishing the validity of a hypothesis [29]. It is a process or study that has the objective of collection of data. An experiment usually tests a hypothesis, which is an expectation about how a particular process or phenomenon works. However, an experiment may also aim to answer a question, without a specific expectation about what the experiment will reveal, or test previous results to replicate results. If an experiment is carefully conducted, the results usually either support or disprove the hypothesis.

In order to get answers to our research question, to test if the clinical guideline structure influenced on the clinicians decision, we chose to carry out a randomized experiment get the clinicians (participants) involved in using the clinical guidelines. This experiment will imitate the clinical situation and asks the participants (clinicians) to check the patient record in order to give a decision shortly before the patient comes for consulting.

The experiment aims at to evaluate if the clinical guidelines structure has impact on its usage and efficiency. Half of the participants were shown the relevant guideline recommendation together with the patient record while the other half had only the general guideline showed. In the experiment, clinician's clinical question and decisions are collected in a Google form in order to evaluate their performance as if they could find the relevant clinical answers when showed the clinical guideline.

At first we intended to recruit real clinicians from hospital, however the cost is relatively high and also as it is a pilot study to research the methods to elicit

requirements not on a large scale so for this time I decided to recruit upper-class medical students who are in their last three years at university. They had some intern experience in different hospital unit thus they could be considered as junior clinicians that meet the entry requirements for participants.

3.3.3 QUESTIONNAIRES

Questionnaire is a quantitative method. Questionnaires have advantages over some other types of surveys in that they are cheap, do not require as much effort from the questioner as verbal or telephone surveys, and often have standardized answers that make it simple to compile data. However, such standardized answers may frustrate users. Questionnaires are also sharply limited by the fact that respondents must be able to read the questions and respond to them.

Questionnaire is a quantitative method. The advantage of questionnaire is that it is easy to administer and cost-affective.

Since we are doing experiment among a certain amount of people so questionnaire is a time saving way to quickly get answers from the participants. Because the questionnaire is a follow up part of the whole experiment, we do not need to worry about that participants refuse to take part in. We will give a scale for each question also the well-structured questions in the form enable participants to understand and choose an answer quickly. The data could easily be analyzed in electronic version.

CHAPTER 4

EXPERIMENT MANAGEMENT

This chapter contains the management of the experiment. Firstly, I would give the background information of the experiment and introduce the different stakeholders that involved in the experiment, then I will discuss about the risk and measurement.

4.1 BACKGROUND

The representation format of clinical guideline and research method were studied in the former chapter, and in order to evaluate the usage of clinical guidelines, how is the clinician's attitude towards the structure and searching function of the guideline, an experiment was designed to imitate the clinical situation and ask the clinician to find out the treatment or decision based on the clinical guideline.

When I was going to study and elicit requirements on the integration of clinical guidelines and EHR, another master student Terje Røsand was interested to use my experiment as a basic source for studying eye tracking with think aloud method. Therefore we mixed out settings together to execute the experiment, the detail information will be presented in Chapter 5.

4.2 STAKEHOLDERS

The experiment was organized by my supervisor Øystein Nytrø, together with master student Terje Røsand. My supervisor Øystein Nytrø with Laura Slaughter are interested to use the experiment and project for further research in Evicare project.

Terje Røsand has recruited the participants and controlled the execution of every participant. He had the interests to test think aloud method with my experiment as a source.

DIPS ASA had provided the interface used in the experiment with the help of master student Trond Elde, DIPS also want to test the interface prototype for further development of the system. DIPS ASA is a company founded as a spin-off from a hospital in Norway and has provided EHR solutions for the Norwegian Health Sector.

I contributed to the method design of the experiment and am interested in eliciting requirements based on the analysis of the experiment results.

4.3 EXPERIMENT SCHEDULE

The experiments were performed spread out the whole October in 2012 in the usability lab in NTNU campus. We let only one participant came to the lab to do the experiment because of the limited facilities and also for master student needed to interview each participant. Thus each time, one participant came to the lab to do the experiment. The anticipated time allocated for each individual experiment was approximately 1.5 hour.

4.4 PARTICIPANTS

In the last chapter I had explained why we chose to recruit medical students for the experiment. Therefore we decided to recruit upperclass students that studying in medical department of NTNU. We sent out emails among medical students studying in NTNU to ask if anyone would be interested in participating in the experiment to find out solutions to improve healthcare and promised them two movie ticket and a lucky draw. 19 students from 4^{th}, 5^{th}, 6^{th} years of study replied the email and agreed to take part in the experiment.

4.5 RISK

Every experiment or research has some kind of risks that affect the validity. Before doing the experiment, we should identify the risks and evaluate the risk. This experiment was a pilot experiment for eliciting requirements on the integration of clinical guidelines and EHR; I never did similar experiment before, therefore there could be some immature design of the methods.

Besides the participants were not really clinicians, their experience with clinical situation differs from real clinicians, thus their performance in clinical case and expectation of the clinical needs may vary from the performance or needs of real clinicians. These factors should be taken into account when analyzing the experiment result in order to reduce the invalidity of the experiment.

4.6 MEASUREMENTS

If we are aware of the measurement of the experiment, we could easily measure if the experiment could answer the research questions. The measurements of the experiment has two part, the first part is whether clinicians could ask the most relevant clinical question, second is to whether they could give the most relevant treatment according to the case and guidelines. By measuring these two parts of data, we could see if the participant had chosen the most suitable treatment. Thus we could be able to answer to the research questions 2,3 and 4 mentioned in chapter 1:

2. Do clinical guidelines provide useful and quick answers to clinician's clinical questions?

3. Do clinical guideline structure affect its usage and efficiency?

4. How do clinicians think of searching function and how should we improve searching function in clinical guideline?

CHAPTER 5

EXPERIMENTAL DESIGN

In this chapter, I will discuss and demonstrate the detail experiment settings and procedures. First I will give a description of the experiment objective, and then there will be explanation of the case and guideline selection for the experiment. At last I will list the variables of the experiment and how we controlled the different variables during the experiment.

5.1 DESCRIPTION AND OBJECTIVE

OBJECTIVE

The experiment was designed to test the usage clinical guidelines, to verify if the structure and recommendation has influence on clinician's performance in turn to elicit requirements for the integration of clinical guideline with electronic patient record.

ANALYSIS

By doing the experiment, we could observe the interaction between clinician and the guideline through the whole process, try to figure out their needs and also based on the experiment we could get some useful feedback from the participants about their experience when using the clinical guideline.

5.2 PLANNING AND PREPARION

5.2.1 CASE SELECTION

When deciding about the experiment case, we all agreed to choose a real case in clinical settings that happened on real person rather than make up one. A real case can reduce the invalidity of the experiment. This case should be a particular

case that could represent a kind of clinical cases and used clinical guidelines when clinician diagnosis the patient. We chose a case related to stroke because stroke is the third most common cause of death is a major cause of severe disability and have major economic consequences. Hospitals can encounter many patients with stroke so the national clinical guideline for stroke is relatively mature.

The case we chose was a clinical situation that a patient went to outpatient clinic for consulting, the clinician checked the patient record and lab results, according to the recommendation in the guideline, he gave a pre-treatment before the patient came. All the information of the patient was strictly anonymous in the experiment.

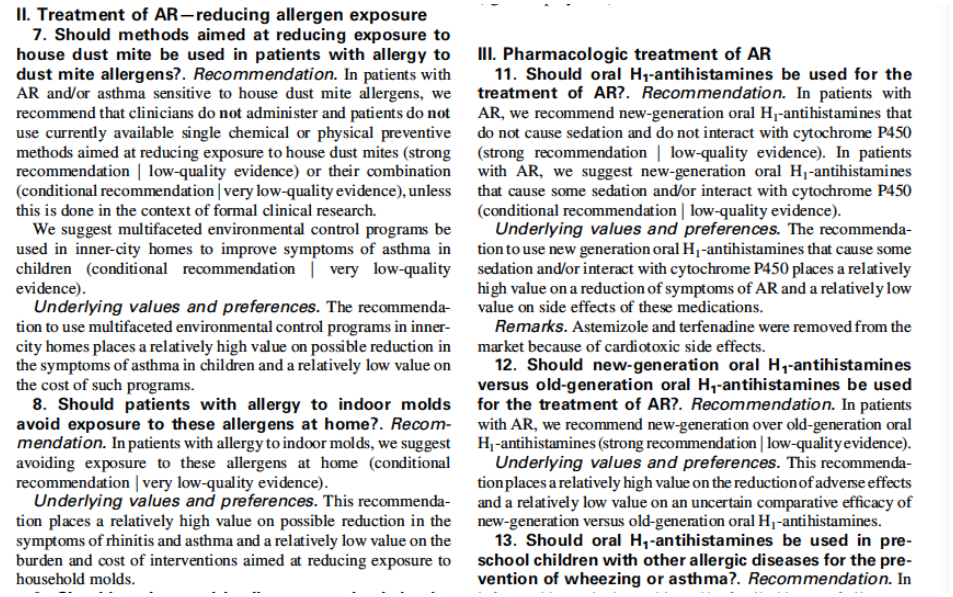
The general description of the case we used in the experiment is:

> The patient is male, born 20.06.1961 that suffered from a cerebral infarction 2 years ago. It was found that he had PFO (patent foramen ovale), which was closed at Rikshospitalet (hospital name). He had been to the outpatient clinic twice before, and this was the third visit. His LDL cholesterol showed a level of 2.4.
>
> And according to the guideline, all patients that had suffered cerebral infarction and has LDL above 2.0 should be offered treatment with statins, which is a cholesterol-lowering drug.

5.2.2 CLINICAL GUIDELINE SELECTION

It is important to choose one presentation format of clinical guidelines for studying the structure and searching function. There are many kinds of clinical guidelines; the measurement of choosing clinical guideline is that the guideline should have some special characteristics or structure that is worthy studying.

At first, I wanted to use a paper-based guideline that has special structure with all the recommendation listed as questions and answers (showed in Fig. 1). But implementing it into web-based searchable format is bit difficult since the experiment will be run on computer screen. While then we found another National guidelines for treatment and rehabilitation of stroke []. It is a web-based international guideline for stroke built by Norwegian Knowledge Centre for the Health Services, it has special format with clear structure and outline. The screenshot of the web-based national guideline is showed in the figure 2.



II. Treatment of AR—reducing allergen exposure

7. Should methods aimed at reducing exposure to house dust mite be used in patients with allergy to dust mite allergens?. *Recommendation.* In patients with AR and/or asthma sensitive to house dust mite allergens, we recommend that clinicians do **not** administer and patients do **not** use currently available single chemical or physical preventive methods aimed at reducing exposure to house dust mites (strong recommendation | low-quality evidence) or their combination (conditional recommendation | very low-quality evidence), unless this is done in the context of formal clinical research.

We suggest multifaceted environmental control programs be used in inner-city homes to improve symptoms of asthma in children (conditional recommendation | very low-quality evidence).

Underlying values and preferences. The recommendation to use multifaceted environmental control programs in inner-city homes places a relatively high value on possible reduction in the symptoms of asthma in children and a relatively low value on the cost of such programs.

8. Should patients with allergy to indoor molds avoid exposure to these allergens at home?. *Recommendation.* In patients with allergy to indoor molds, we suggest avoiding exposure to these allergens at home (conditional recommendation | very low-quality evidence).

Underlying values and preferences. This recommendation places a relatively high value on possible reduction in the symptoms of rhinitis and asthma and a relatively low value on the burden and cost of interventions aimed at reducing exposure to household molds.

III. Pharmacologic treatment of AR

11. Should oral H_1-antihistamines be used for the treatment of AR?. *Recommendation.* In patients with AR, we recommend new-generation oral H_1-antihistamines that do not cause sedation and do not interact with cytochrome P450 (strong recommendation | low-quality evidence). In patients with AR, we suggest new-generation oral H_1-antihistamines that cause some sedation and/or interact with cytochrome P450 (conditional recommendation | low-quality evidence).

Underlying values and preferences. The recommendation to use new generation oral H_1-antihistamines that cause some sedation and/or interact with cytochrome P450 places a relatively high value on a reduction of symptoms of AR and a relatively low value on side effects of these medications.

Remarks. Astemizole and terfenadine were removed from the market because of cardiotoxic side effects.

12. Should new-generation oral H_1-antihistamines versus old-generation oral H_1-antihistamines be used for the treatment of AR?. *Recommendation.* In patients with AR, we recommend new-generation over old-generation oral H_1-antihistamines (strong recommendation | low-quality evidence).

Underlying values and preferences. This recommendation places a relatively high value on the reduction of adverse effects and a relatively low value on an uncertain comparative efficacy of new-generation versus old-generation oral H_1-antihistamines.

13. Should oral H_1-antihistamines be used in preschool children with other allergic diseases for the prevention of wheezing or asthma?. *Recommendation.* In

Fig. 5.1 Paper-based guideline with question and answer recommendation

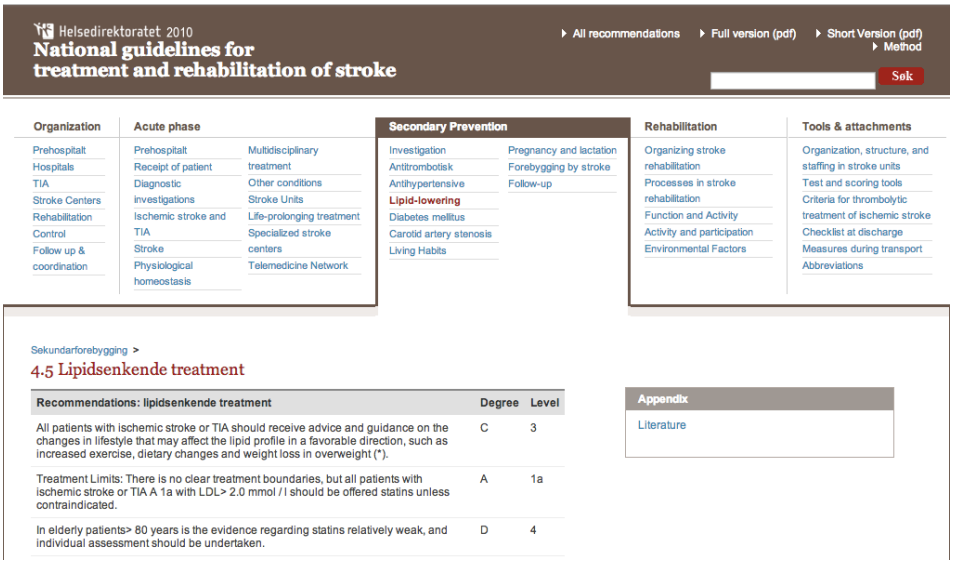


Fig. 5.2 National guideline for rehabilitation of stroke on helsebibliotekte.no

We could see in this picture, the guideline outlines are divided into five sections displayed in the top. They are organization, acute phase, secondary prevention, rehabilitation, tool& attachments. Under each section, there is more detailed classification of recommendations. The structure is clear and users can easily

find wanted information by clicking on the links. In addition, this guideline is newly designed by Norwegian Knowledge Centre for the Health Services (Nasjonalt kunnskapssenter for helsetjenesten). Therefore, it is a good example to learn about the structure and searching effects of the guideline.

5.3 INTERFACE SYSTEM AND USER GUIDE

The content of the experiment was set up in a trial system of DIPS Company. It was an interface prototype that embedded the patient record, lab results and the relevant clinical guideline together in sub windows of the interface. We manually enter the patient information into the DIPS interface systems. The following data were recorded into the DIPS prototype systems for this experiment:

- Patient general information
  Age, Gender, Height, Weight, Race, current medication, medical history
- Patient lab results
- Patient medical record
  Four medical journals on date 01.10.10, 28.10.10, 13.05.11, and 11.04.12
- Clinical guidelines
  National guidelines for treatment and rehabilitation of stroke

The interface will be showed in the screenshots below (Fig. 5.3, 5.4, 5.5, 5.6, 5.7) with the demonstration of how to use it. The system is in Norwegian but we can clearly see the structure and recognize the different part. The pictures were captured after the experiment. (The red spot is the eye-tracking path generated by the eye-tracking machine after the experiment for another master student Terje with his research).

To start using the system, the clinician should first search the patient name, (example name “Henriken, Stein”) in the prototype system and then they can get a document overview of the patient; they can open each document and check for the medical records as well as lab result.

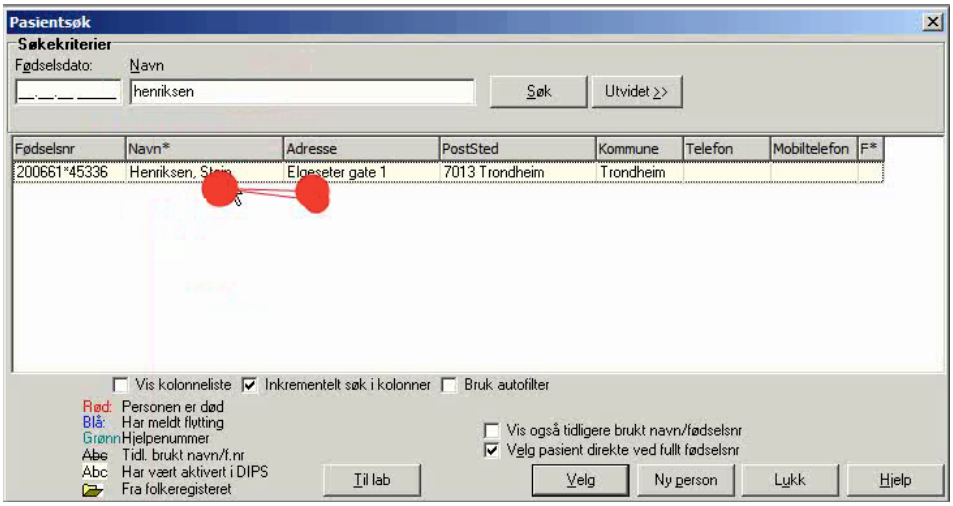


Fig. 5.3 Patient searching for Henriken, Stein

Then user can click the patient name to see the latest medical records of the patient. Each medical record has date, department, author, etc.

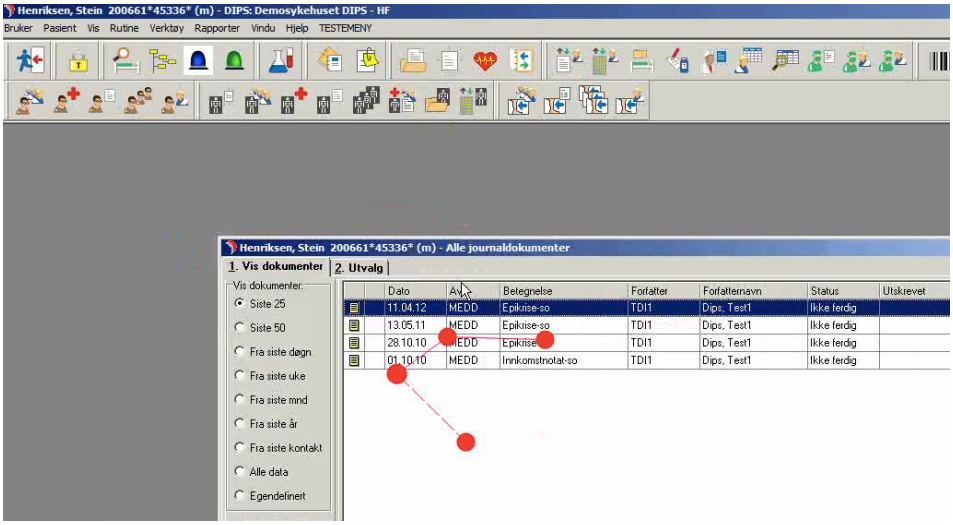


Fig. 5.4 Medical records for patient Henriksen, Stein

Below are the lists of the patient lab results. Each result contains detail information of when and where the test takes place.

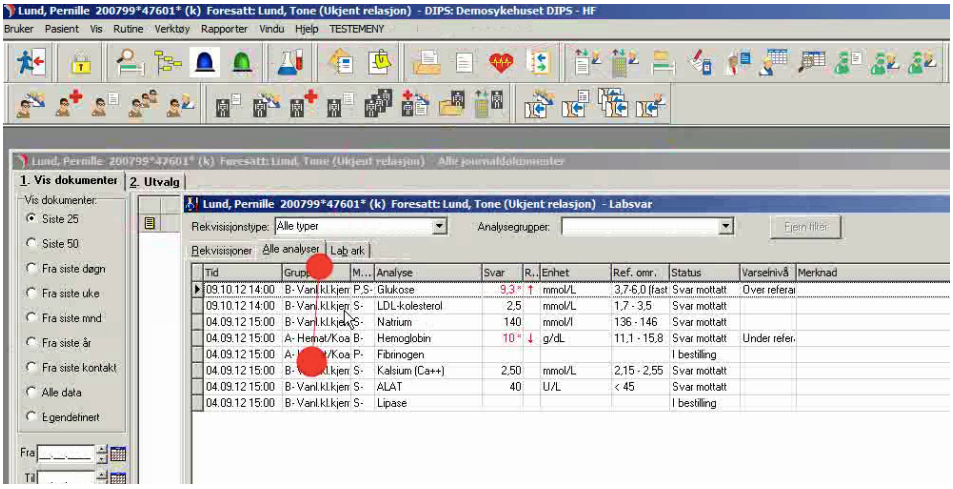


Fig. 5.5 Lab result of the patient “Henriksen, Stein”

If the clinician wants, he can open the relevant clinical guideline to check recommendation; the guideline will pop up in a new window in the prototype system showed in the picture below.

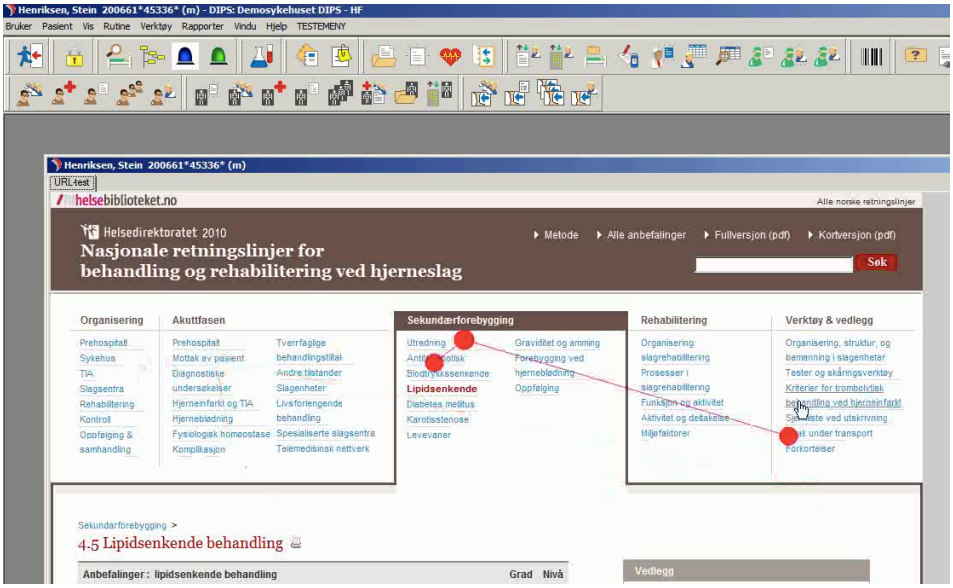


Fig. 5.6 Clinical guidelines embedded in DIPS Interface

For the experiment, this interface system will be used. It contains all the information for the experiment, in the next part, the setting and procedures of the experiment will be elaborated.

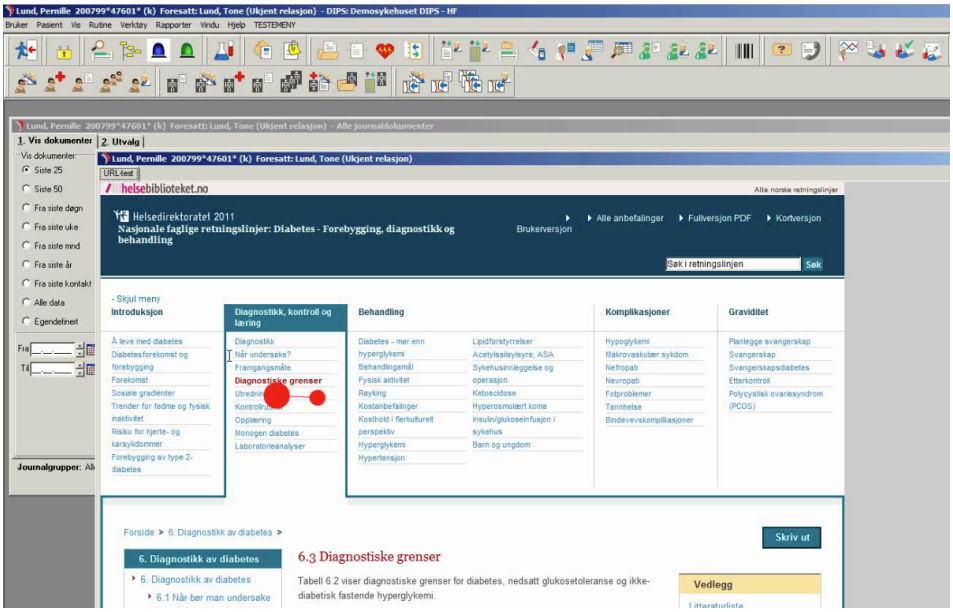


Fig. 5.7 Interface with all the windows displayed

5.4 SETTINGS AND PROCEDURES

EXPERIMENT SETTINGS

The participants were randomly divided into 2 groups. The entire groups were presented with the interface system in the beginning of the experiment. They need to perform three tasks in the experiment; the content of three tasks are the same for each group while we only control the showing content of the national guideline. The content of the three tasks is listed as below:

- Task 1:
  Find the patient in DIPS, read the last discharge summary, write the clinical questions that come to mind in a form “Answer sheet”.
- Task 2
  Find the intervention or action (e.g. prescribe medication) according to your clinical questions or hypothesis. Write down the 2nd version of clinical questions if it is needed.
- Task 3
  Clinicians make final decision; write down the final discovery in the form 3 on screen 2. Fill in “feedback questionnaire of clinical guideline usage”.

We asked the clinician to write down the clinical questions is because the clinical questions could be a measurement of whether the participant had given the best practice to the case.

VARIABLES OF THE EXPERIMENT

The variable of the experiment is the content of the clinical guideline. For group 1, the participants were showed the first page of the general guideline (http://www.helsebiblioteket.no/Retningslinjer/Hjerneslag/Forord-og-innledning) without giving them directly to the relevant recommendation page. While for group 2, they were provided directly to the related cholesterol lowering treatment recommendation page in the national guideline. (http://www.helsebiblioteket.no/retningslinjer/hjerneslag/Sekundarforebygging/Lipidsenkende-behandling).

Table 5.1 Settings of different groups

Name	Provided guideline content
Group 1	Pop up window of the overall national guideline
Group 2	Pop up window with the relevant treatment recommendation page in the national guideline

The first group was presented with the general guideline while group 2 was presented the cholesterol lowering treatment recommendations directly. In order to make it clearer, I have made two process pictures for each group (Fig. 8, Fig. 9). The difference of the setting between the two groups is marked as red words.

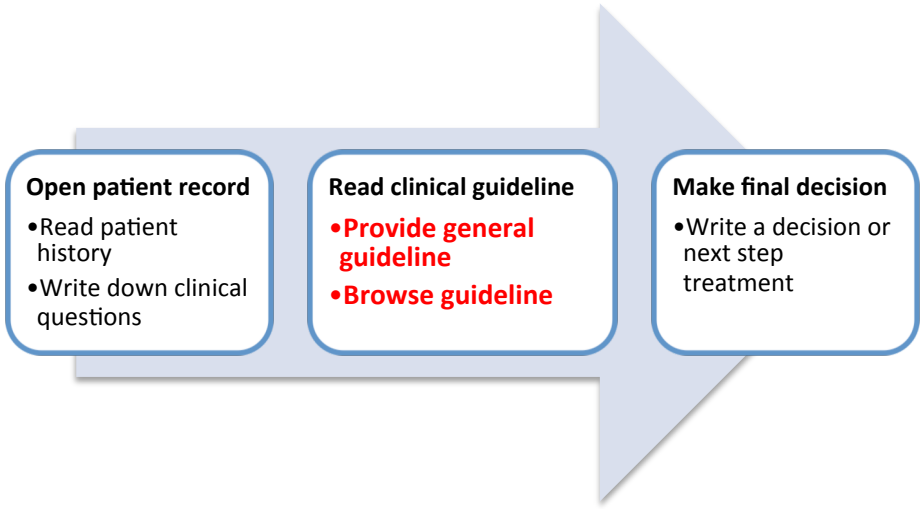


Fig. 5.8 Experiment process chart for Group 1

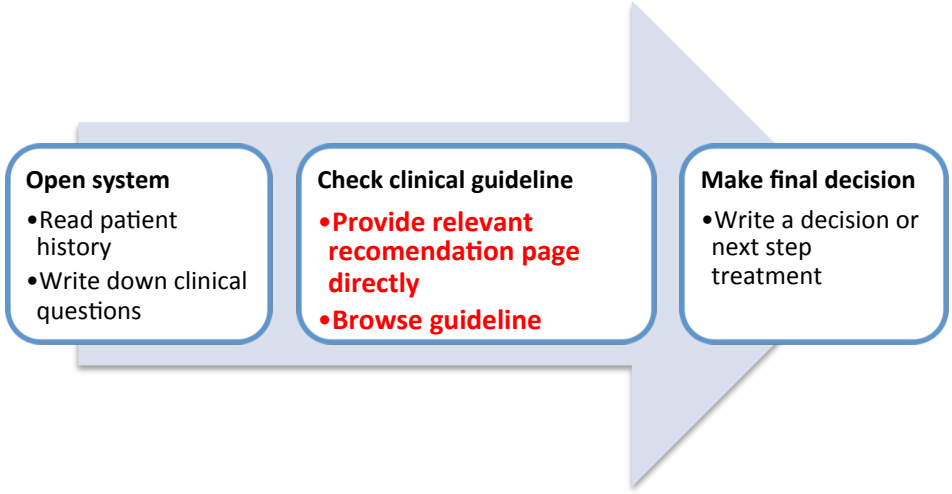


Fig. 5.9 Experiment process chart for Group 2

HYPOTHESIS

The hypotheses for this experiment are listed as below:

1. Clinical guidelines provide useful answers to clinician's clinical questions.
2. Clinician can always find answers to their clinical questions in the clinical guideline.

3. When giving the most relevant recommendations, clinician could make quick and the most relevant treatment.
4. The national Web-based guideline has good structure and makes it efficient to use.
5. All clinicians would use searching function in the web-based guideline to get information.

DATA COLLECTION

Before and during the experiment, different data were collected to measure different hypothesis of the experiment; the data were collected before, during and after the experiment. We had two forms and one questionnaire for the participant to fill in. The detail information described as below:

Background form: Before doing the experiment, I designed a form (in Appendix) for the participants to fill in; it collected the participant's previous experience with clinical guidelines and clinical practice.

Clinical questions and final decisions (Named as Answer sheet) When participants were doing the three tasks, they were asked to write down their clinical questions and final decisions in a Google form called "Answer sheet" showed in a second computer screen. This second computer screen is besides the main computer screen that has the prototype system.

Feedbacks about using the clinical guideline: After participants completed the three tasks and wrote down their final decision of the case, we asked them to fill in a questionnaire to get the participants' feedback towards the using of clinical guideline. The data will be used to evaluate the usefulness and structure of clinical guideline. The form is built in Google can be found in Appendix.

In order to eliminate unknown factors that would affect the randomization of the experiment, participants cannot share the content of the experiment with each other.

CHAPTER 6

EXPERIMENT EXECUTION

6.1 PREPARATION

The usability lab locates in the NSEP (The Norwegian EHR Research Centre) building near St Olav hospital. Each time one participant came to the lab to take part in the experiment. The whole experiment was recorded but the data can only be used for the project study and all the information will be kept anonymous.

There will be two computer used during the experiment. One is the main computer that used to display the prototype system (see Chapter 5.3). All the information related to the experiment itself was displayed on the main screen. The second computer (screen 2) only used to record different data generated from the experiment.

6.2 PROCEDURES

The following content is the detailed procedures for the experiment; the procedures are mixed with another master student Terje's experiment. His part was marked with letter "T" in the end.

INTRODUCTION PHASE

a) The first step is to introduce the experiment by telling them about the general information of my project and Terje's project.
b) Ask the participants to fill in consent form from different stakeholders of the experiment, in order to make the participants
   - Project consent form
   - DIPS consent form
   - Background information/ demographics

c) Teaching the DIPS interface system which was introduced in part 5.3(see above)
d) Introduce the clinical setting and the patient case (case was on paper on the table)

TEST PHASE

- Introduction of the lab equipment and the experiment procedure
- Calibrate the eye tracker (T)
- Explain that we cannot give help during the test and the participants can abort the experiment at anytime

a) TASK 1

Settings: Test person sit in front of the table, face the main screen (which is DIPS interface include case, all information about patient) and screen2 (Answer sheet), a paper (only case content) on the table.

Task: Find the patient in DIPS, read the last discharge summary, write the clinical questions that come to mind.

Procedures:

- Present task text on (screen and) paper
- Open DIPS interface
- Start task1 and write down clinical questions on screen2
- Do the RTA (retrospective think aloud) if relevant, *TR: Ask one question about method*

b) TASK 2

Settings: Same as last 1. But on screen1 there will be a little change, the clinician is given access to the guideline (either the general guideline or the relevant recommendation page according to their group). The guideline will be on a pop up window in the DIPS interface.

Task: Find the intervention or action (e.g. prescribe medication) according to your clinical questions or hypothesis. Write down the 2nd version of clinical questions if needed.

Procedures:

- Present task text on (screen and) paper
- Start task2 and write down 2nd version of clinical questions on screen2

- Do the RTA (retrospective think aloud) if relevant. (T)

c) TASK 3

Settings: Same as last one, Introduce lab module in the DIPS system.

Task: Ask the participant make final decision; write down the final discovery in the Answer sheet on screen 2. Fill in Feedback questionnaire of clinical guideline usage on screen 2.

Procedures:

- Introduce Lab module
- Start task3 and write down clinical decision in Answer sheet on screen2
- Fill in Feedback questionnaire on scree 2
- Do the RTA (retrospective think aloud) if relevant (T)

FINALIZATION

Giving thanks to the participant for their cooperation and precious time.

We used different forms to collect different data during the experiment. The relationship between tasks and the forms are showed in the table below.

Table 6.1 Relationship between task and data collection forms

Time	Needed Form	Data Input	Place
Before tasks	Background form	Background info	Paper
Task 1	Answer sheet	Clinical questions	Screen 2
Task 2	Answer sheet	Revised clinical question if have	Screen 2
Task 3	Answer sheet	Final decision	Screen 2
After 3 tasks	Feedback questionnaire	Feedbacks	Screen 2

6.3 DATA VALIDATION

19 participants took part in the experiment. 19 people filled the background form and answer sheet, while 18 people had filled the feedback questionnaire. After the experiment, I checked all the data, although some participants did not answer some question but there is not need to remove the data. In the next chapter, I will present the data and try to interpretive the data.

CHAPTER 7

RESULTS AND ANALYSIS

This chapter gives the overview statistics of the data collected from the experiment and also I try to interpret the data to evaluate my research questions.

7.1 BACKGROUND INFORMATION

The 19 participants were medical students from 4th till 6th grade, has the age from 23 to 32. They had different experience from clinical practice and most of the experience was internships; while 5 participants had no experience from clinical practice. It is not surprising to see that most of them did not have too much experience in clinical practice since they are students. Among the 19 participants, 13 of them sometimes use clinical guideline while 4 rarely use and 2 often use guidelines. 15 of the participants prefer to use electronic clinical guideline while only 4 participants considered electronic clinical record and paper-based clinical record are the same.

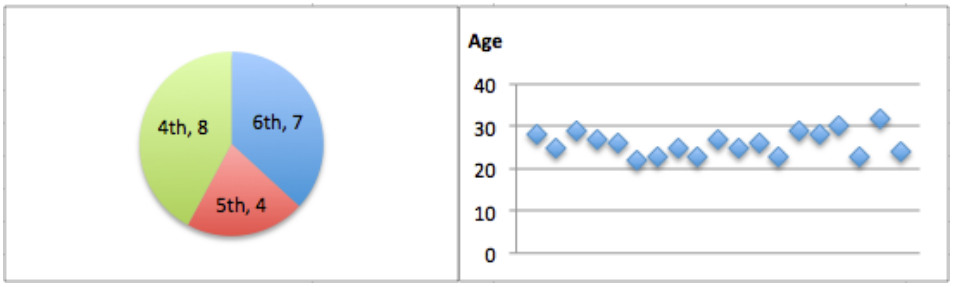


Fig. 7.1 Age distribution and years of study of the participants

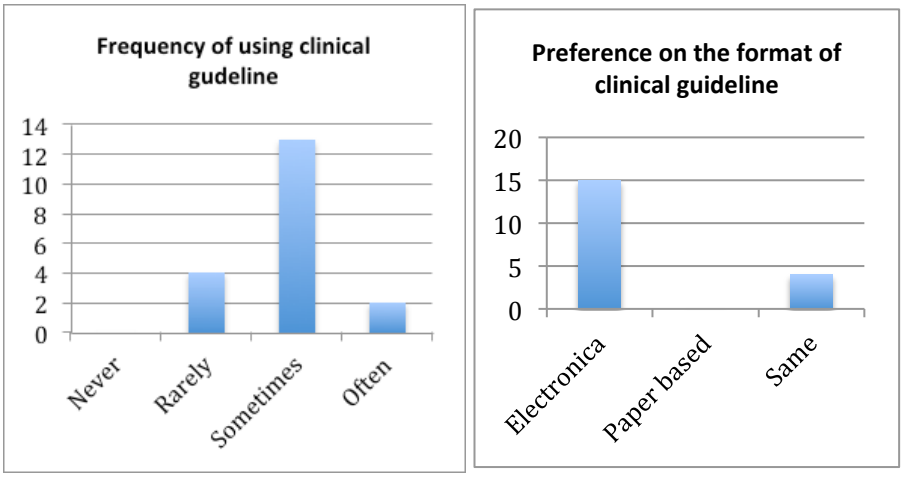


Fig. 7.2 Frequency and Preference of using clinical guideline among participants

We could see that medical student all have used clinical guideline in their study or work; the majority of them preferred electronic clinical guideline. Obviously, among the young generation born around and after 1980s, electronic devices are popular, in university study, most learning materials are available in electronic forms and course project are done or delivered via e-learning system. That is why most of them prefer electronic version of document rather than paper-based guidelines. Also paper-based document make it difficult to search for information.

But to my surprise, among the 19 participants 7 of them never used www.helsebibliotek.no before, and 8 of them rarely used it, 3 sometimes used it and only 1 participant often used its.

Helsebiblioteket.no is the official online library website of Norwegian Electronic Health Library. It is a publicly funded online knowledge service for healthcare professionals and students in Norway. It provides free access to point-of-care tools, guidelines, systematic reviews, scientific journals, and a wide variety of other full-text resources for health-care professionals and students. The national guideline used for my experiment is published by this facility as well.

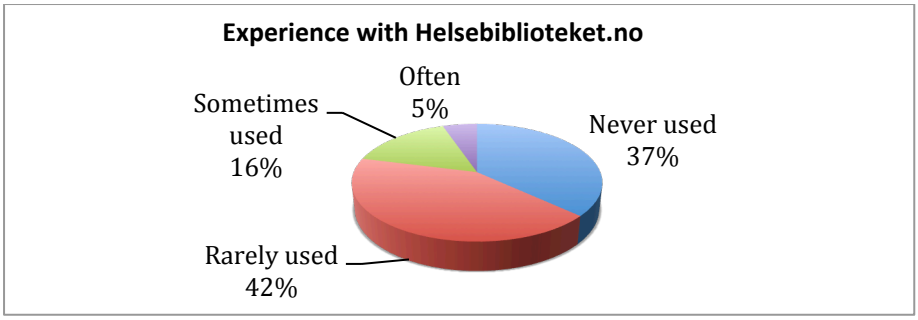


Fig. 7.3 Experience with Helsebiblioteket.no among participants

Before doing the experiment, I expected most of the participants had already used Helsebiblioteket.no and were familiar with it. But from the data collected, we can see that they are not familiar with Helsebiblioteket.no, it maybe because of in school, teachers do not and thus it could be a factor that affects the searching time and user experience of the online guideline. But from another point of view, because the majority were not familiar with the website, as new user of the web-based clinical guideline, their opinions is convincing.

7.2 Experiment Results

7.2.1 Clinical decisions

We generated the clinical decision made by group 1 and group 2, list the brief answer in table 7.1 and 7.2 showed as blow. We could see great difference on the medication between group 1 and group2.

Statins medication

In Group 1, only 2 participants clearly state the statins medication should be continued; while the other participants generally did not mention clearly about the medication but inquired the patient current situation, any new symptoms, previous medication and medical history etc. And most thought that the patient should be under the control of the GP. P6 that clearly stated the medication statin should be used in Group 1 is a person who often uses clinical guidelines; therefore we can see he had found the most relevant recommendation by himself.

In Group 2, 7 among the 10 participants clearly pointed out that statin therapy should be started and also specified the dose, 2 said that the patient should be

continue with lipid-lowering medication. All of them mentioned that the patient LDL-value is above 2.0 and according to the guideline, the LDL should be treated to be lower than 2.0.

Table 7.1 Final decision made by group 1

Participant	Final decision about the patient
P1	Ask the patient if he had side effect of drug use and current medication
P2	Ask about the patient medical history and his monitoring with his GP, recommend the use of clopidogrel (Plavix) 75 mg x 1.
P3	Ask the patient how he has had it since the last meeting. Any marked difference in symptomatic policy? Ask about the patient history and drug use. Also his plan, Meet GP next time.
P4	Follow-up of PFO, analysis the risk and late effects of PFO. Control medication. Give instructions on diet and lifestyle on national guidelines.
P5	Ask GP to take over the patient and follow him up regarding his compliance with medication and new episode.
P6	Medications: Plavix 75mg x1, Simvastatin x1 (NEW!). Continuous Plavix treatment. LDL of 2.4, and this is an indication for initiation of prophylactic statin treatment. Patient should take Simvastatin*1 as new medication. Will provide advice on lifestyle and diet.
P7	Establish healthy lifestyle. With regard to secondary prevention. He should continue with clopidogrel monotherapy under the supervision by a GP. GPs should follow up on important parameters such as BT, lipids and blood glucose. Ask about family history of stroke and other cardiovascular diseases.
P8	Focus on monitoring of the patient for lifestyle and preventive prophylaxis. Inform about risk behavior to the patient. Further questions: What is it that worries the patient and concerns s,that a psychological / psychiatric follow-up would be appropriate? Moreover inform general about risk behavior and what the patient should be aware of.
P9	Ask patient about the new stroke symptoms or get new diseases? Drug used today? Sequelae today? Whether BT, glucose, pulse are regularly? Encourage increased physical activity, or weight loss.

Secondary prevention

While almost all the participants considered the secondary prevention of the patient since patient status is steady but the secondary prevention is considered important and stressed in different parts of the national guideline. Also almost

all participants would ask the patient to pay attention to lifestyle and dietary changes in order to keep shape.

Table 7.2 Final decision made by group 2

Participant	Final decision about the patient
P10	Mapping the patient's lifestyle and examine whether he is interested in counseling. The patient does not have abnormally high cholesterol levels, but according to national guidelines can be offered statin therapy when his LDL-value is above 2.0.
P11	Ask about the latest feeling of the patient, if the condition is not better, he needs cholesterol or glucose but if the situation is good, patient can go to the next control.
P12	Discuss about the patient compliance problem of medication, life style and diet. See lipid status in terms of cholesterol and assessed whether statin therapy is indicated.
P13	The patient is considered to be fully recovered. Monitor new LDL (latest available data was 2.4), will set up a statin treatment with a treatment goal <2.0 according to national guidelines. Going to take general medical status and preliminary blood tests. Advise patients about lifestyle and any dietary changes..
P14	Assess the patient's lifestyle with regards to diet and exercise and alcohol. Take blood pressure. Check lipid status. Patients should wealth, according to the guidelines go on statins after TIA, if statin status not satisfactory.
P15	The patient still had LDL-cholesterol over 2,should start a cholesterol-lowering drug, which according to guidelines. Patient should continue with exercise and good lifestyle. Besides continuing with platelet inhibitor previously, possibly slightly lower dose, eg 75 mg per day. Medications: Aspirin-E 75 mg x 1,Simvastatin 40 mg x 1
P16	The patient should continue to be on Plavix. According to his blood tests he has one LDL above 2.0, he should be below 2.0 according to the guidelines and therefore starting the treatment with lipid-lowering drug. Ask him about possibly cardio grew, illness in the family. Tell him the other risk factors that have contributed to his heart attack.
P17	The patient has LDL of 2.4, according to the guidelines recommend that LDL should be below 2. Patient should start be handling with Simvastatin 40 mg x1. Upon any side effects, the dose may be reduced to 20 mg x 1. He should also maintain a healthy diet and exercise.
P18	According to the guidelines, his LDL cholesterol is slightly elevated. Discuss about diet, and possible start a new control of cholesterol-lowering medication in 3 months. Consider monotherapy of Plavix according to guideline.
P19	Want to start statin therapy, acc. Guidelines to achieve LDL <2.0. I want to ask the patient about diet and exercise, also in relation to motivation to change this if the patient is physically active. Want to

find contraindications to treatment start, cf bleeding risk and prior TIA / stroke and reassess the patient secondary prophylaxis existing according to current guidelines.

7.2.2 FEEDBACK TOWARDS CLINICAL GUIDELINE USAGE

17 people had filled in the Feedback questionnaire after they finished the three tasks. The data from these 17 people were analyzed.

Among Group 1 (totally 8 person filled in the questionnaire), 1 person (who sometimes used clinical guidelines) thought the guideline structure was "very reasonable" and the rest thought the structure was "reasonable". One person pointed out the guideline could be more apparent. 5 people can find answers to their clinical question in the guideline. 2 people could not find the answer but they thought it was in the guideline and 1 people thought the answer is not in the guideline.

In Group 2 (9 people filled in the questionnaire), 2 people thought the structure was "very reasonable" and 7 people marked "reasonable". 3 people can find answers to their clinical questions, while 3 people could not find it but thought it was not in the guideline, and another 3 people thought the guideline do not have the information they want to find. This is partly because some of their clinical questions were asking about the patient situation or history rather than the real clinical question, and also when they were presented the specific page of the guideline, they may not have the process to get familiar with the guideline.

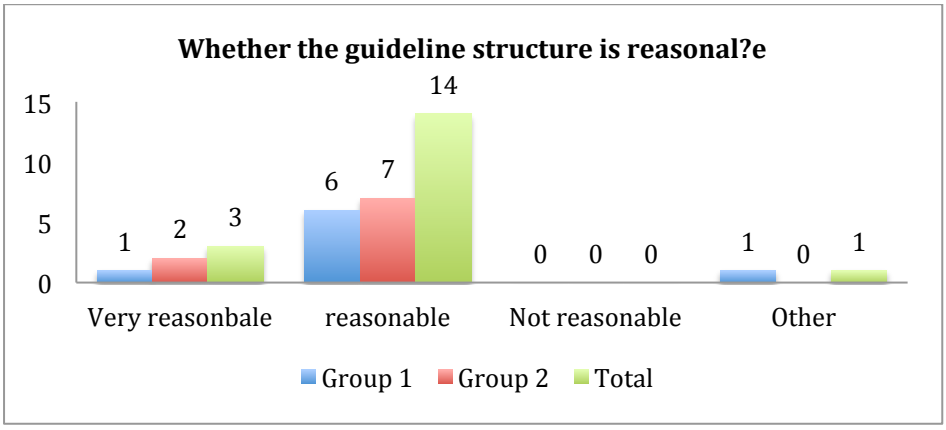


Fig. 7.4 Statistics of the guideline's rationality

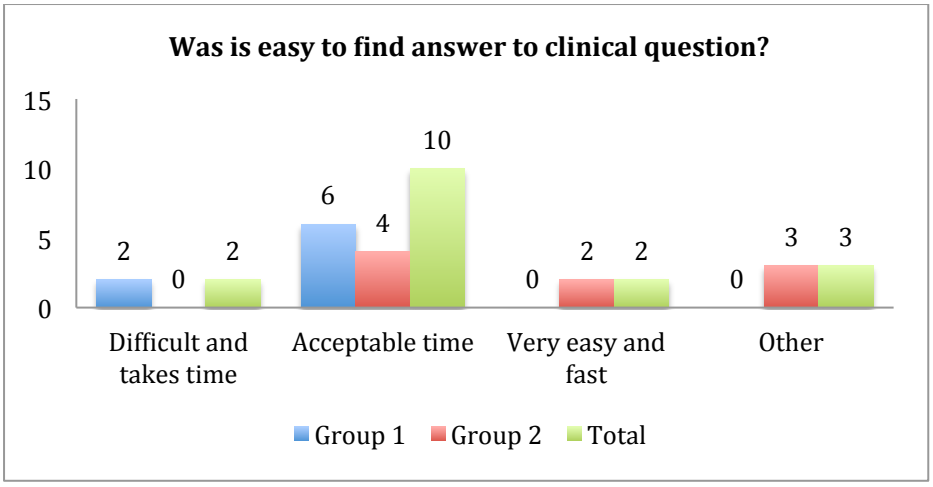


Fig. 7.5 Statistics of time spent on searching the guideline

The next two pictures are showing the statistics of the clinical guideline's advantage and disadvantages chosen from the participants. We could see "clear specification of clinical data" listed as the most popular advantage of the guideline. After that is the "easy web-based navigation" chosen by 10 people. 8 people thought the guideline has sufficient recommendation. While another wrote, "Standardized, evidence based treatment. Reliable source for support in clinical decisions." Therefore, the structure of the clinical guideline is indeed an advantage of the national guideline and the web-based navigate has make it fast to search and locate the information.

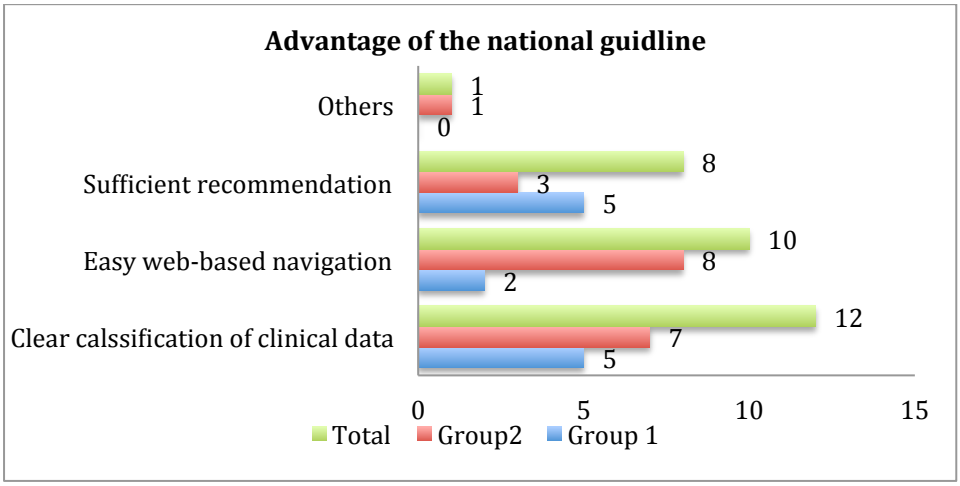


Fig. 7.6 Statistics of the advantage of the national guideline

6 people thought the guideline is time consuming; most of them were in Group 1 that was given the whole general clinical guideline. The other 2 answers in Group 1 do not choose any disadvantage of the clinical guideline, while people from Group 2 mentioned "the guideline may not get updated fast enough", "search function is not optimal, do not have the auto suggestion". However, all these disadvantages are the general weakness that all kinds of clinical guidelines need to improve.

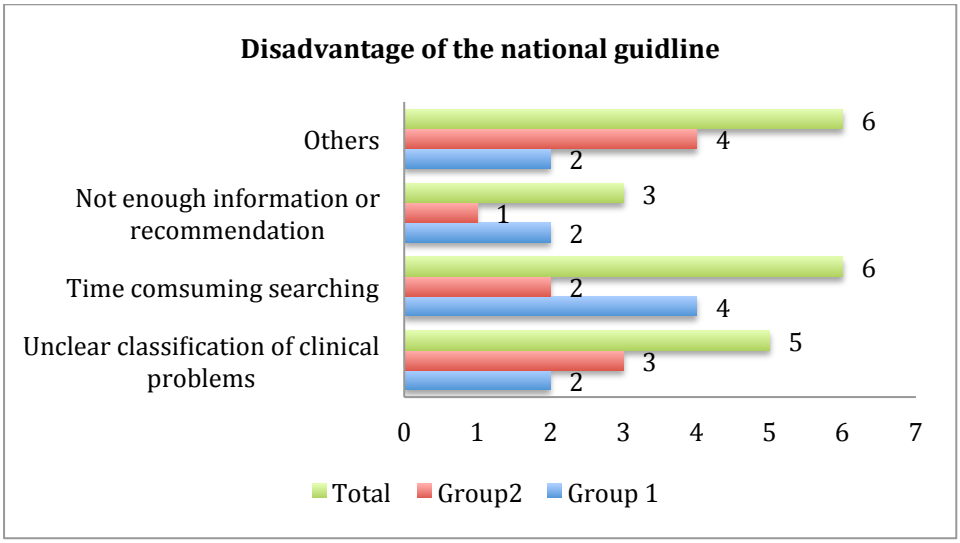


Fig. 7.7 Statistics of the disadvantage of the national guideline

7.2.3 SEARCHING HABIT AMONG PARTICIPANTS

14 participants in the experiment did not use the searching function while 5 people did not notice the search function. 3 people from Group 2 said because the most relevant part of the guideline was presented, they did not think of using search function. 2 people said they were afraid the searching could not provide the relevant information and it was easier and quicker to just browse the guideline according to its structure.

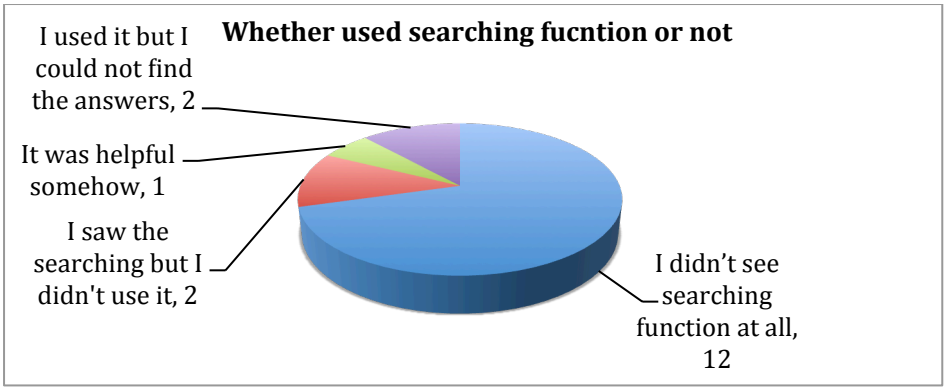


Fig. 7.8 Statistics of the using of searching function

This is the most surprising result in the experiment, since I thought all the participants would use searching function but the fact is they did not use it. The reason may be because they were not used to do searching when they are looking at the guideline since they are students studying at school, they read guideline sometimes in order to get an overview of the disease data, and also a real patient case need comprehensive understanding of the situation so many factors should be considered when diagnosis or giving treatment. By only searching partial data could not get the overall cause and effect.

Among the 3 people that used the searching function, 2 of them said they could not find the answers to their clinical questions, they wrote because the searching result was not applicable and they found zero result. Another one said it was helpful somehow but the recommendations are not structured well, he could not find the answer at first glance.

The searching function is not obvious in the national guideline; it is only a small button on the right top of the page. And the searching function is too simple; there is no hint or auto-correction or when you input word.

7.2.4 POSSIBLE SOLUTIONS TO IMPROVE GUIDLIEN USAGE

The participants were asked to choose one or more solution that improves guideline usage, which can be helpful for them. The data showed in Fig. 7.9.

Most of the participants would like to have more clearly structured recommendation and auto rank of the recommendations based on the patient record content in the EHR system. This is also the study point of my experiment. Since searching in clinical guideline is not popular among clinicians in clinical

practice, the patient record should be more powerful by providing the auto searched result based on the context and patient data.

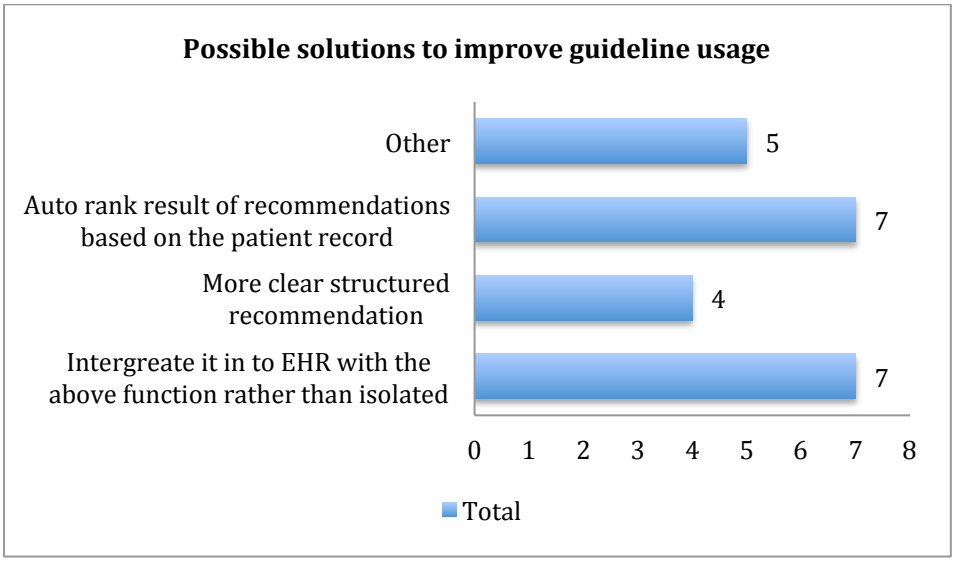


Fig. 7.9 Statistics of chosen possible solutions to improve guideline usage

CHAPTER 8

CONCLUSION AND SUMMARY

8.1 CONCLUSION

From the interpreted data in the last chapter, we are able to verify our hypotheses and answer the research questions 2,3,4. The results of the hypotheses is showed in table 8.1,

Table 8.1 Results of verifying hypotheses

Number	Description	Result
1	Clinician can always find answers to their clinical questions in the clinical	Rejected
2	Clinical guidelines provide useful answers to clinician's clinical questions.	Accept
3	When giving the most relevant recommendations, clinician could make quick and the most relevant treatment.	Accept
4	The national Web-based guideline has good structure and makes it efficient to use.	Accept
5	All clinicians would use searching function in the web-based guideline to get information.	Reject

Research questions

2. Do clinical guidelines provide useful and quick answers to clinician's clinical questions?

If presented well with the most relevant recommendations, clinical guideline be useful and provide quick answers to clinical questions. But

3. Do clinical guideline structure affect its usage and efficiency?

Yes, clinical structure affects the usability of the guideline, clear and well defined structure make it easy to locate information and can improve the performance of clinicians.

4. How do clinicians think of searching function and how should we improve searching function in clinical guideline?

Clinicians are not used to use searching function in the clinical practice but a good searching function may be accepted and will be used by clinicians. Therefore it is a challenge to research on how to make the searching efficient when clinicians are using the guideline. We could learn from Google searching function and also try to provide auto searching when clinicians are using the guideline.

5. What are the possible solutions and requirements for integrating clinical guidelines with EHR?

From the whole experiment, we could see that it is demanded to integrate clinical guidelines with EHR. Clinicians would like to have such system that could help decision-making. Clinicians could benefit from such systems by reducing the working time and providing latest and reliable best practice evidence. The integration should notice the following matters12r:

1. Be able to updated with the latest evidence
2. Building a friendly structure and interface
3. Reduce the clinicians searching time as more as possible by providing auto search function when clinicians are writing in the patient journal or
4. Provide auto ranked recommendations to clinicians based on the patient record, such as medication, treatment, therapy etc.

There should be more experiments and research to reveal the more detailed requirements for the integration of clinical guideline and electronic patient record.

8.2 LIMITATION

Three main limitations of the study should be noticed.

First, the participants in the main study were students, who are not experienced clinicians. Their limited experience in clinical practice may have been reflected in the way they performed the tasks. Real clinicians maybe perform differently as students since they had more experience and knowledge. Second, the method designed for the experiment may not be the best, and the case was limited to stroke. The national guideline cannot represent other format of guidelines so the research result is limited.

However, this project is a preliminary study to elicit requirements, we will design more experiments and recruit real clinicians to take part in to reduce the potential threat of using medical students as test person.

8.3 SUMMARY

This master project began since last August, but due to medical reasons, I have postponed the deadline till now. Also because of some unpredictable factors, the experiment case and data was revised many times.

It has given me a deep understanding of experimental design; I had read lots of papers to do the preliminary study and also became familiar with some medical field. And I had broadened my knowledge for requirement analysis and clinical decision support related issues.

During the whole process, my supervisor encouraged me and had given me valuable advices on the whole design of the experiment, helped me selected the case and recruited people. Master student Terje also helped me a lot during the whole project, I will offer my deep appreciation to them.

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APPENDIX

Background form (Norwegian)

(1)

Bakgrunnsopplysninger

Dette skjemaet brukes for å registrere bakgrunnsinformasjon. Opplysningene vil holdes anonymt.
Takk for din deltakelse.

1. Kjønn
☒ Mann ☐ Kvinne

2. Alder
28

3. Hvilket årstrinn går du på?
☐ Fjerde ☐ Femte ☒ Sjette ☐ Annet

4. Fra hvilke(n) avdeling(er) i sykehus har du mest erfaring?

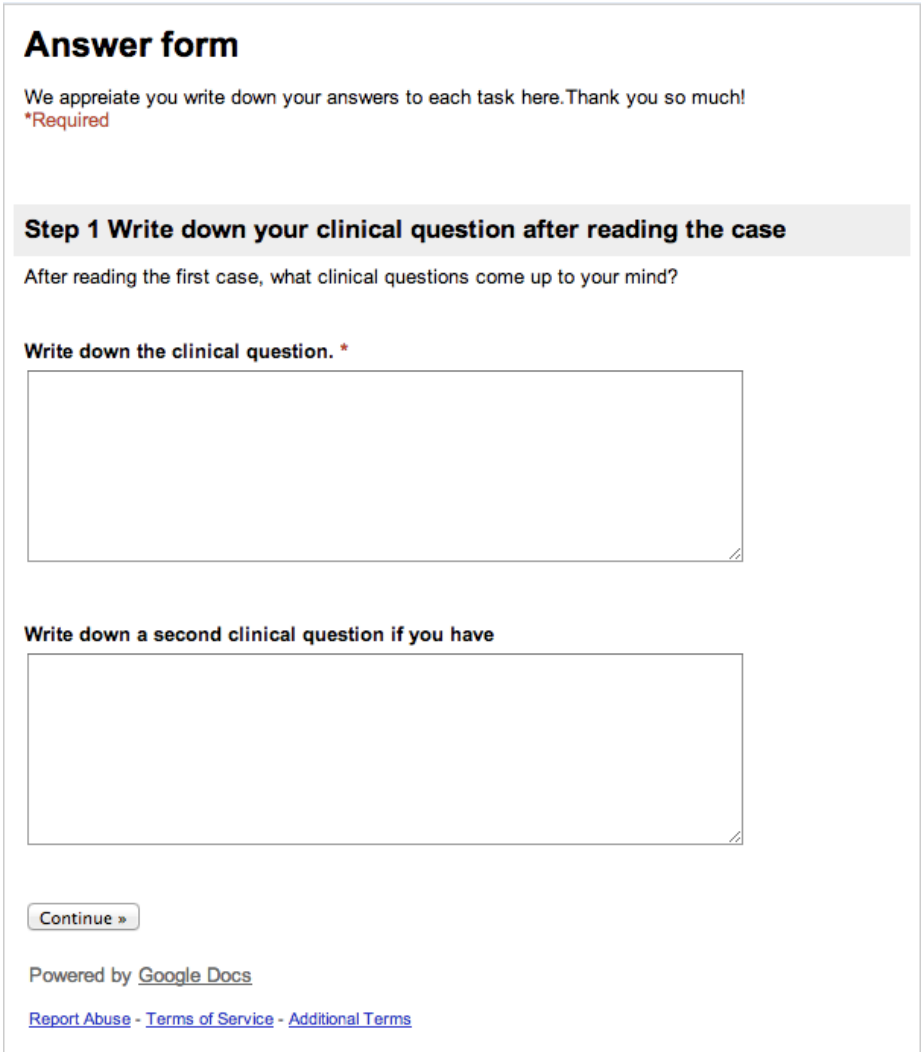
Rus, psykiatri

5. Hvor ofte bruker du kliniske retningslinjer i studiene eller praksis?
☒ Sjelden ☐ Av og til ☐ Ofte ☐ Aldri

6. Foretrekker du elektroniske eller papirbaserte retningslinjer?
☐ Papirbasert ☒ Elektronisk ☐ Likegyldig

7. Bruker du helsebiblioteket.no som kilde for kliniske retningslinjer?
☒ Sjelden ☐ Av og til ☐ Ofte ☐ Aldri

Answer form(sheet) to record clinical questions and final decision



Answer form

We appreiate you write down your answers to each task here.Thank you so much!
*Required

Step 1 Write down your clinical question after reading the case

After reading the first case, what clinical questions come up to your mind?

Write down the clinical question. *

Write down a second clinical question if you have

Continue »

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Answer form

Step 2 Revise your clinical question when reading the guideline

When you are reading the guideline and the patience case again, do you want to revise your clinical question, if yes, write down here again and you can go back to the last page to copy and paste if needed.

Clinical question

Write down your pre-cousulting when you are readding and searching guideline and information

Are there anything in your mind that you would do for this patient?

« Back Continue »

Answer form

*Required

Step 3 Write down your final decision according to the patience case and guideline

Your final decision before the patient comes, could be a medication, prevention and so on.

Final decision *

« Back Submit

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Feedback questionnaire

*Required

1. Is the guideline structure reasonable or can the structure of the guideline guide to what you want to look for? *

- ○ Very reasonable
- ◉ Reasonable
- ○ Not reasonable
- ○ Other:

2. Could you find the answers to your clinical questions in the guideline? *

- ◉ I can
- ○ I can not find but I think it should be in the guideline
- ○ I can not find and I think it is not in the guideline
- ○ Other:

3. Was it easy to find the answers to your clinical questions in the guideline? *

- ○ Difficult, takes some time
- ○ Acceptable time
- ◉ Very easy and fast
- ○ Other:

4. What do you think is the advantage of this national guideline? *

You can choose more than one and also write down your own answer.

- ☐ Clear classification of the clinical data
- ☐ Easy web-based navigation
- ☑ Sufficient recommendations
- ☐ Other:

5. What do you think is the disadvantage of the guideline?(multiple choice) *

You can choose more than one and also write down your own answer.

- ☐ Unclear classification of clinical problems
- ☑ Time consuming searching
- ☐ Not enough information or recommendations
- ☐ Other:

6. Did you find the searching function useful when you are searching in the guideline? *

- ○ I didn't see searching function at all
- ○ I saw the searching but I didn't use it
- ○ It was helpful somehow
- ◉ I used it but I could not find the answers

Continue »

Regarding searching function

7. When giving a list of searching result，did this list of results match the your clinical questions? *

- ◯ It was not easy to choose
- ◯ It was easy to choose
- ◯ It was hard to say
- ◯ Other: _____

8. When giving a list of searching result, was it easy to select one particular recommendation above alternative recommendations? *

- ◯ It was not easy to choose
- ◯ It was easy to choose
- ◯ It was hard to say
- ◯ Other: _____

9. If it was not easy to select one particular recommendation, what of the following reasons you think that may cause this? *

You can choose more than one and also write down your own answer.

- ☐ The recommendations are not relevant
- ☐ The recommendations are within wide topics
- ☐ I need to choose based on the patient's specific situation
- ☐ The recommendations are not structured well, I could not find clear answers at the first glance
- ☐ Other: _____

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If we are going to improve the searching functions, which of the following do you think should would be helpful for you? *

You can choose more than one and also write down your own answer.

- [ ] Auto rank result of recommendations based on patient record content
- [ ] More clear structured recommendations
- [ ] Integrate it in the electronic patient record with the above functions rather than isolated from the patient record
- [ ] Other:

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