Interaction design in a complex context: medical multi-disciplinary team meetings

Oscar Frykholm¹, Marcus Nilsson¹, Kristina Groth^{1,2}, Alexander Yngling¹

¹Media Technology and Interaction Design

KTH Royal Institute of Technology

Stockholm, Sweden

² The Innovation Centre

Karolinska University Hospital

Stockholm, Sweden

{frykholm, marcuni, kicki, yngling}@kth.se

ABSTRACT

In order to improve collaboration on, and visualisation of, patient information in medical multi-disciplinary team meetings, we have developed a system that presents information from different medical systems to be used as a support for the decision process. Based on field studies, we have implemented a high-fidelity prototype on tablet-sized displays, and tested it in a realistic setting. Our evaluation proved that more patient information can efficiently be displayed to all meeting participants, compared to the current situation. Interaction with the information, on the other hand, proved to be a complicated activity that needs careful design considerations; it should ultimately be based on what roles the meeting participants have, and what tasks they should complete. Medical decision-making is a complex area, and conducting interaction design in this area proved complex too. We foresee a great opportunity to improve medical work, by introducing collaborative tools and visualisation of medical data, but it requires that interaction design becomes a natural part of medical work.

Author Keywords

Interaction design; Computer-supported cooperative work; Medical decision-making; Multi-disciplinary team meetings

ACM Classification Keywords

H.5.3 Group and Organization Interfaces

General Terms

Design; Human Factors.

INTRODUCTION

Medical decision-making is an increasingly complex task that involves a number of medical specialisations and technologies. This has led to a growing trend of organising staff in teams, and having several medical specialists care for the patient [23]. In the highly specialised care we have focused on, a team of physicians of different specialisations coordinates and discusses the results of their specific

examinations. This kind of team-based care is necessary for making the best judgement of a patient's condition, disease and treatment.

Technology support in healthcare settings poses special difficulties, as it must attend to different roles and settings, as well as to patient safety issues. Communication failures have been identified as a common cause of error in healthcare, with a majority occurring in verbal communication settings between clinical staff [13]. Therefore, particular attention is needed with respect to designing collaborative technology that supports multi-disciplinary team meetings (MDTM).

Information Visualisation in MDTMs

The use of MDTMs has become an important work process in cancer-related healthcare [6, 9, 10, 22, 25]. In such meetings, a number of medical specialists present and discuss available patient information that is based on, for instance, examinations, previous treatments, lab results, and meetings with the patient. Even though a large amount of information, stemming from different medical systems and sources, is discussed in these meetings, we have noticed that technology support for managing the information is partly quite rudimentary or even non-existing [4]. Information technology can be used to make MDTMs more efficient and collaborative, thereby allowing the medical specialists to make more informed decisions [14, 11, 3]. [1] reports on a gap between formal documentation in the electronic medical record (EMR) and actual clinical workflow. [21] also conclude that one needs to think of "*information repositories (such as patient record systems) ... as places where work is done*". This calls for making all relevant patient information available at the MDTMs where varying aspects of the patient case must be considered.

Visualisation of data in MDTMs leads to an improved structure of the team communication [16] and improves the overall task performance [8]. In studies of multi-disciplinary collaboration, [17] propose that patient data, as presented in the EMR, should be designed for easy scanning, that is, to minimize the need for searching for information and rather focus on consistent presentation. [18] demonstrate that the use of real-time data entry, displayed to all participants at the MDTM, increases the

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quality in collecting staging information for the patient record and the national cancer database.

[11, 22] have discussed advantages of introducing functionality such as pointing and drawing on radiology images, when presented and discussed in MDTMs. [15] report on the importance of offering an *interaction space* where medical specialists collaboratively can work on patient information. Their study shows the need for technology to support interaction between participants in different locations, specifically the use of *pointing and other indexing gestures*. Interaction with, for example, radiology images presented at MDTMs has also been identified as needed, but often not supported for the larger audience [19, 24]. However, [12] report that it can be negative to introduce certain advanced technology in MDTMs, as “*real-time data gathering at the meeting takes more time and risks turning the meeting into a group form-filling exercise*”.

Design Process

A wide range of technical solutions, from small devices such as smart-phones to large-scale software systems such as EMRs and decision-support systems, are making their way into medical work. These devices and systems are increasingly used in daily work at hospitals, inevitably affecting how the clinical work is conducted. According to [20]: “*Such changes present interesting opportunities for interaction design but also present new challenges for evaluation*.”. At the same time, conducting participatory design in a complex context such as health care has proved difficult [7].

For three years we have worked together with surgeons and radiologists in a research project aimed at bringing collaborative information technology to MDTMs. Taking a holistic point of view of their work processes and the collected information they encounter daily, we have cooperatively designed a system aimed at supporting their work. The system aggregates patient information from different sources and gives the medical specialists an interactive layer on top of the information, in which they can collaboratively present, search and annotate patient information. The system has now been introduced in a simulated MDTM, with the intention to evaluate its qualities, learn how it applies to the collaborative work in the meeting, and also to get an insight in how it can be used in a larger context of the daily work of the medical specialists.

To our knowledge, no formal user studies of high-fidelity prototypes to support the collaborative work in MDTMs have been conducted in realistic settings. Our results show a great need for visualisation of patient information in the MDTMs, but at the same time that such technology should be carefully designed to actually support the specific work processes in this time-critical setting.

Figure 1. Decision conference: Radiologists in the foreground, video-conference display in top left, projections of radiology images in far left, other medical specialists in the audience on the right. Photo: Staffan Larsson, STH, KTH.

THE SETTING

Karolinska University Hospital is one of Scandinavia’s premier healthcare facilities and has a responsibility to deliver specialised care within the Stockholm region. The highly specialised care of the upper part of the abdomen is one of those, undertaken by the department of gastrointestinal surgical care (Gastro). There are about 20 surgeons at Gastro that focus on diseases in the liver, pancreas and oesophagus. In 2011, the department had a throughput of 2,222 referred patients, of which 1,502 were discussed in an MDTM (decision conference, see below), and 445 were surgically treated. Gastro has defined a standardised care chain with three kinds of MDTMs: decision conference, preoperative conference, and post-operative conference. We have chosen to focus our research on the decision conference, as it is one of the most crucial points in the care chain, that is, regarding patient information visualisation and collaborative work.

Decision Conference

The weekly decision conference (see Figure 1) is attended by 5-15 medical specialists and physicians from different sites, it handles 15-25 patients, and lasts about 60-90 minutes. As the decision conference constitutes a triple-assessment of each patient, at least four medical disciplines must attend (radiology, surgery, oncology, and pathology). Usually a few other disciplines also attend, such as transplantation and hepatology at the liver conferences.

Each patient discussion starts with a brief introduction of the case, made by the *presenter* who is either a surgeon or the referring physician, including information such as: patient status, comorbidity, on-going treatments, subjective symptoms, and a question for the conference on what should be decided on. The presenter has prepared the material before the conference. Then a *radiologist* presents the radiological findings, by showing images from a number of radiology examinations. The radiology images are displayed, using two projectors, on the wall facing the other conference participants. The dimensions of the

projections are each approx. two by one and a half meter, and the wall is three to six meters from the participants. Usually, the most active participants are seated close to the projections, in the middle of the room. The radiologists presenting the information are seated at a radiology workstation in front of the other participants, where they have three high-resolution displays connected to their Radiology Information System and Picture Archiving and Communication System. The radiology presentation is an important part of the conferences, as it shows the best available representation of the patient's internal affected area (organs, tumours, blood vessels etc.). The radiologist has in advance prepared a statement, both in text and using a number of "bookmarked" images with relevant findings (e.g., suspected tumours). Although one specific image in the stack of images might show the finding most clearly, the radiologist scrolls up and down on adjacent images to show the three-dimensional space of organs and vessels. The radiologist is in full control of this presentation; during most of the presentation no one else is speaking and the radiologist handles the images (choosing which examinations to display, scrolling images, and pointing to specific areas). Towards the end of the presentation, other participants join the discussion by asking questions, asking the radiologist to show specific areas [24], and starting to work out the diagnosis. The *chair* (a senior surgeon) is now responsible for the discussion, making sure that all relevant patient information is taken into account and a consensus decision on diagnosis and treatment is made. During the discussion, the presenter takes notes on the final decision, and later adds it to the EMR. A more detailed presentation of the discussions is given in [3].

As conference participants might be located in other hospitals, a videoconference system is used to broadcast radiology images (same as on the two projectors), video of the local conference room, and audio.

Even though several medical specialists are present, usually only a few of them are active during each case discussion: the physician who referred the patient, the presenter, the radiologist, the chair, and other medical specialists who have been in contact with the patient. Besides these key participants, a number of surgeons in training might be present in the conference. When questions are raised in the conference, the presenter and certainly the referring physician might know the answers. Otherwise there is no patient information readily available for the participants (apart from the radiology). The EMR is available on the radiology workstation, but almost never used as it takes too long time to access it and find information. However, we have observed one case discussion where a portable computer happened to be available and, therefore, used to access the EMR. If they cannot get the information at once, they make a decision with several alternatives; the actual decision will later be decided on based on the missing information that is checked up after the conference.

DESIGNING THE CLINICAL JOURNAL

A participatory design process has been undertaken together with Gastro for over three years including field studies with interviews and observations, design activities and workshops with medical specialists, as well as initial evaluations of the proposed system [2]. We have, during this time, worked closely together with surgeons and radiologists. Working in several iterations of observation, design and evaluation, we have moved from paper sketches to the development of a high-fidelity prototype. We have also moved from initial evaluations of the paper sketches, to actually testing the interactive prototype in a realistic setting.

The system has been designed primarily to support the decision conference as they are conducted today. However, such a system cannot be designed only for one specific situation; it both relies on information from previous steps in the care chain and sends information to the next steps.

The interface for the Clinical Journal has been designed to support five main principles, devised in collaboration with the medical specialists and based on our own observations.

Case-based presentation: In MDTMs, where at least four different medical specialists are present, it is important that all participants get a complete overview of the patient, that is, the entire case is presented. Therefore, they need to take into account, for instance: other diseases (than the one primarily discussed), on-going treatment, previous decisions, and the general state of the patient. We have chosen to present overview first and offer details on demand [5], both in order not to risk cluttering the interface and to design consistent patient presentations [17].

Add, do not repeat: The EMR usually contains a large number of notes for each patient, and information is easily repeated over several notes. That is, a physician first reads previous notes, then adds a new note describing the patient and what has already been stated, and appends new information. Focus should be on accessing all information and keeping it up-to-date, without the need to repeat it.

Interactive and including: Our intention is that all participants should have equal possibility to interact with all patient information (both text and images). Even though a participant might not be active in the discussion, she should still be able to search for, and even add, information. The participants have clear roles (as described earlier), and we wanted to learn what different specialists find most important by tracking what information they interact with. As participants might be located at another site, the system must also be connected over a network in order to display the same information to all participants.

Checklists: Patients are unique, but the way physicians look at a case can on an overall level be broken down to checklists. There are certain things they always need to look at, and the use of checklists can help avoid overlooking important information.

Figure 2. Timeline of all patients.

Figure 3. Patient overview.

Figure 4. Detailed patient information.

Figure 5. Organ view.

Figure 6. Pointing and drawing on a radiology image.

A structured list of patient information: As reported in [3], we have worked on structuring most of the medical information relevant for patients at Gastro. We now use this list as a basis for the information in the Clinical Journal. The most relevant information is displayed prominently in the interface (to give an overview), but all information from the EMR is accessible on demand. This way, we have standardised patient information and thereby allow for easier comparison of different patients, for instance, to find patients with similar symptoms and history.

The Interface

The Clinical Journal intentionally has a compact interface of five main views to navigate through. Figure 2 shows the timelines of all patients to be discussed during a certain MDTM. There are four main steps in the care chain, which are displayed as background blocks of different colours (green=coordination, yellow=decision, red=treatment, blue=post-operative). The small icons symbolise notes in the EMR (such as examinations), and specific events (such as MDTMs). Choosing one of the patients, an overview (Figure 3) is displayed where the most relevant information on that specific patient is collected: the patient's timeline at the top, text information about the patient on the left, comorbidity and a video of the patient in the middle, a sketch of how the organ is affected on the top right, a set of icons representing a selection of conducted radiology examinations below the organ, and finally information on the present consensus decision is shown in the lower right corner. A detailed view of all available patient information (Figure 4) can be accessed if a meeting participant wants to check-up on specific information or add new information. The complete list is extensive, and therefore divided into seven sub-views. Typically the presenter, who is responsible for taking notes during the conference, will use one of the sub-views to record what is being decided during the case discussion. In the prototype this view was statically implemented as a way of showing the structure and how information could be stored. Clicking the organ sketch takes you to the full organ view (Figure 5), where tumour affection can be set on standardized regions of the organ (here: the pancreas), and if the tumour has spread to neighbouring blood vessels and organs. Clicking an icon of

a radiology examination takes you to the radiology view (Figure 6), where it is possible to scroll a stack of images, and collaboratively point and free-hand draw on the images.

NB: all patient information in the images is anonymous.

Shared Interaction

The Clinical Journal has been developed for tablet-sized displays and can simultaneously be used on any number of devices in a meeting. All patient information is exactly the same on all devices and instantly updated when a change is made. Apart from standard interaction with the user interface (i.e., navigating between different views and updating patient data), we have implemented two modes:

Shared navigation: Any navigation a user makes in the interface is sent to all other devices (who are also in shared mode) and displayed. For instance, if a user navigates to another view, all other devices will be taken to that view.

Private navigation: A user can choose to go “offline”, and thereby be able to navigate her device without affecting any of the other devices. Patient information is still updated on all devices when a change is made.

Furthermore, in the radiology view, pointing and free hand drawing is implemented (see Figure 6). Users simply point on an image on their device, and a cursor (along with the name of the user who is pointing), is displayed on the same image on all other devices. By clicking a button to enter a “Drawing” mode, a user can in the same manner point to an image and move the finger to draw. The drawing is sent to all other devices as soon as the user raises the finger. As an extra feature, the drawing will appear (fading out) on the adjacent 20 images (ten below and ten above).

Technical Details

The system consists of a database back-end with a web facade, and an iPad application that fetches its data from the back-end. The back-end system is written in a combination of JSP and Java. The application is written in Objective-C, and communicates over HTTP with the back-end for sending and retrieving data. For shared navigation a bespoke protocol is used, which distributes navigation events from one device to other subscribed devices.

METHOD

This evaluation is the culmination of a comprehensive set of participatory design activities conducted over the last three years. Activities include field studies, interviews, workshops, sketching, participatory design prototyping, and evaluations at varying levels of fidelity [2]. The prototype was tested in a simulated decision conference with seven medical specialists: two radiologists, one liver surgeon, three pancreas surgeons, and one surgeon specialised in endoscopic retrograde cholangiopancreatography (ERCP). One of the specialists has had an active role in the entire design process, while the others have at least seen the intended system at different early stages.

Figure 7. All participants.

Figure 8. Radiologist on the left, presenter in the foreground, large shared display on the right.

One of the radiologists presented all cases, while the other radiologist participated as an ordinary member. The ERCP surgeon arrived after the case discussions and only participated in the concluding discussion. As all participants were located in the same meeting room, video-conferencing was not used. All specialists have actively attended decision conferences on a weekly basis for three to six years, and all but one are senior medical specialists. The surgeons are all familiar with the role as presenter, and all but one with the role as chair. The simulated decision conference was held in the same room where the conferences usually are held. The participants were given one tablet-sized display each, and an extra device was connected to a large 42” HD display in front of the participants (see Figure 7 and 8).

One of the study leaders made an introduction to the prototype and the devices, by explaining functionality and interaction using a dummy patient. The participants got to test the system and the devices using the dummy patient for a few minutes before the real case discussions. The system had in advance been prepared with information on three patients, real but anonymous. The participants were instructed to discuss them one at a time, and to act as if this was a real decision conference. One of the radiologists and one of the surgeons (who would act as presenter) had been informed about the patients in advance, and had had a chance to prepare their presentations (which they would normally do). One of the participants was instructed to act as chair (without being able to prepare), and the others as regular participants. The three case discussions lasted 10, 8,

and 3 minutes respectively, which in average is a normal time period (e.g., the first case took over 10 minutes when it was discussed at the real decision conference). After the three cases, there was a longer discussion between the study leaders and the participants on the application, the devices, and how they affected the meeting situation.

All interaction with the devices during the case discussions was individually logged in the system. That is, each time a participant clicked on something in the interface, a timestamp was recorded together with the specific event. Data from the presenting radiologist was unfortunately lost in an unrecoverable crash after the study, but this should have minimal effect on the results, as our primary goal was to analyse the interaction by the other participants.

The entire evaluation was video recorded using two cameras; one fixed on one side of the room, and one hand-held camera operated by a study leader. Afterwards, during analysis, we watched the recordings and categorised key situations and comments, such as: interaction with the devices, how they collaborated, and what support the system brought to the presentations and discussion. We then returned to the categories and watched the episodes in order to analyse in more detail what occurred and why they made the comments. We also watched selected episodes together with one of the medical specialists who participated in the evaluation, as we wanted to learn how the case discussions actually progressed (which is difficult for a layman to understand), and to ask more thoroughly about the experiences of the system.

RESULTS

Upon start of the first case, the chair took charge of the discussions at once, calling for initial presentations by the presenter and the radiologist. The case discussions followed much in a similar manner as during regular decision conferences. There were differences in how the participants used the system, in terms of how much they interacted with their individual devices; one of the participants made few interactions, while others explored the patient information quite a lot. Interestingly, the participant who interacted very little with the system was one of the most positive to the whole idea of presenting more information in the MDTMs. He felt that the system would add support to the discussions by presenting an overview of patient information, without having to interact with the system.

Logged Interaction Data

The logged interaction data from the individual devices were analysed focusing on the amount of interaction for each user and where in the application the interaction took place during the three cases (see Figure 9).

The numbers represent events that were triggered by user interaction and are not a measure of the time spent in the different parts (which would not give an accurate view of what they were doing).

Figure 9a and 9b: Logged interaction events for different parts of the application per user. Categories on the x-axis relate to Figures 2-6. “Shared/private” relates to switching between shared and private mode. Note the different scales on the y-axis: interaction with the Organ and the Radiology views were substantially higher than with the other views.

Instead they are a measure of the users’ activity in different parts of the system. The “Shared/private” category shows how many times the user switched between private and shared mode. We can see that all users except one were quite active switching between the two modes. All users spent around $\frac{2}{3}$ of the time in shared mode and $\frac{1}{3}$ in private mode, except for the chair who spent all of the time in shared mode. Surgeon 2 was quite active during the whole study. Part of this activity was looking at other patients than the one currently discussed, even browsing through the dummy patient. We assume that this higher activity comes from a curiosity of exploring the system.

Case-Based Presentation

The patient overview (see Figure 3) has been thoroughly designed together with the medical specialists in a number of design activities [2]. We have aimed at presenting just enough patient information in that view, as to cover most of what will be discussed in the decision conferences (except the radiology examinations, which has a separate view).

It turned out that the participants actually requested more information to be displayed directly in this overview, as they did not want to click to reveal certain information (e.g., information about specific comorbidity). The text information on the left side, although generally considered useful, was considered to clutter the overview if prepared with too much text (i.e. if they had to scroll). What the medical specialists wanted was more use of keywords that

describe, for instance, other diseases or previous treatments. These keywords should then be linked to their original source (the note in the EMR). This approach was also discussed related to the connection between diagnosis and radiology images:

But if one picks up this idea of “core journal”, and if you have a diagnosis, then it would be good if you could connect the flagged images, so that you via top-down can click on it and be able to see the images that proves that the diagnosis is correct. – Surgeon 2

The participants claimed that this way of presenting patient information would be an improvement compared with today. It would give them a better overview of all relevant information that must be considered. We have targeted the Clinical Journal on precisely this task: adding patient information visualisation to the decision conference, and aggregating information on the entire case.

The overview of the different areas of the patient also served as checklists of information that they must take into account. For instance, seeing the comorbidity sketch in the middle of the patient overview would visually remind them to check for other complications; a white marking means there is no information available, a green marking means there are no problems, and a red cross means there is a disease or problem in that area. This also highlights the importance of negating information; the area has been looked into and there is no problem.

To support the case discussions, one of the participants suggested that the interface should progress in the same manner as the case discussion progresses. Starting with a condensed overview of patient information, which is actually what the interface showed during the simulated meeting, they could, preferably automatically, be presented with the other related views. That is, after the initial presentation, the interface would move on to displaying radiology examinations. After that, as a third and concluding step, the interface would support the consensus decision. This new view would display the recorded decision, planned treatment and how it will be carried out.

Roles and Tasks

As described earlier, the system was used to varying degrees by the participants, and much of the differences can be attributed to both what role they had in the meeting in this study, and what role they usually have in these meetings. The presenter, after giving the initial presentation of the patient, is responsible for taking notes of what is being said. It is therefore natural for the presenter to navigate the system to, for instance, update the organ view and record the decision in the patient information list. The data in Figure 9 support that the presenter mostly conducted these tasks. We also see that the presenter is the one who interacts with the list of all patients, and is the one who mostly interacts with the organ view and the main patient overview. This supports the presenter's role as the main

navigator of the system as the patient overview is the hub where all other views are accessible. The radiologist naturally displays a number of radiological examinations and interacts a lot with the radiology view. The chair has an overall responsibility to make sure the discussion progresses, and is therefore less likely to interact with the system. This passive interaction with the system is supported in the data shown in Figure 9 as it can be seen that the chair interacts with the system the least. The other users in the study are free to explore the information as they like, and in Figure 9 it is shown that they actually interacted mostly with the radiology view. This also underlines the presenter's role as the main recorder of the discussion and decision.

One of the main concerns about using the system in decision conferences was raised by those who did not have a formal role: they thought that the device and the system distracted them from following the discussion, which is something they really need to pay attention to:

One really has to concentrate, everyone must concentrate on the same thing and discuss the same thing. [] And it divides my attention to have this display. - Surgeon1

It is also important to consider that Surgeon 1 usually is the chair in ordinary decision conferences. He may thereby have felt more distracted than other participants that have a secondary role.

In the concluding discussion after the three case discussions, the participants discussed this issue vividly. The general impression was that all participants did not require a device on their own, but that they should be able to easily borrow one from any other participant for a short while in case they wanted to ask about or show something specific. They even suggested that only a few key participants should have a device on their own (the presenter and the chair) and the devices could circulate upon demand. This contradicts the fact that the individual who acted as a chair during the study rarely interacted with the system and the comment by Surgeon 1 above, considering the he also usually has the chair role during ordinary decision meetings. The main comments were that those key participants are formally requested to use the system, as there are things they need to present or record. The other participants have tasks of another character, which indicates that they require functionality and interactivity of a more simple nature, they should basically be able to point at images or information which is currently displayed:

It is the presenter who should be working with this thing [the device]. The others can follow on it or the large display and point, but not fiddle with zooming, drawing, going back and forth. - Presenter

Following this line of reasoning, it is not really a question about which participants should have a device on their own,

but rather what tasks they need to complete and how the system and device can support that.

Clinical Journal in the Care Chain

Although we evaluated the system in one specific setting (the decision conference), comments were also raised on how it can be used along the entire care chain:

“If all this was filled out in advance, then it would be of great assistance ... It would be of great assistance at pre-op conferences. It would of great assistance at surgery, to have access to this. - Surgeon 1

At the same time, concerns were raised on how the system would actually be used in reality. Now, the practical side of their work came to play. If the system adds more work for them, such as extensive preparations before the conferences or maintaining the same information in two different systems, then the specialists did not appreciate the system.

DISCUSSION

Medical informatics and decision-making today is a complex area; the amount of information medical personnel encounter daily is extensive. Improving visualisation of and interaction with medical information is also a complex area: demands are high (new systems must improve existing work processes and infrastructure), and stakes are high (in essence it is about human lives). But on the other side, potential gain (more efficient health care) is also high.

Patient Information Overview

Medical work is to a large extent based on information stored in the EMR, but it does not mean that it will be available in situations when decisions need to be made. If it is available, it is usually text-based and the clinicians need to scan several notes and pages in order to get a proper overview. Information availability not only means the information needs to be accessible from the EMR, it must also provide the clinician an awareness of what information there is about the patient. Making relevant information available in situations where decisions are made (cf. [3, 11, 14, 21]) has been our aim with the Clinical Journal.

With the current EMR, patient information can be accessed during MDTMs via the radiology station, but the radiologists who are logged in to the system only have access to a limited amount of the patient information. To get full access, another physician needs to login. It is not difficult to bring in a separate computer from which patient information can be accessible, but in the best of worlds it also needs to be connected to the video conference system in order for the remote participants to get the same view. Still, the information in the EMR is only provided in text-based notes, one for each encounter with the patient. In the Clinical Journal, we not only give access to patient information from the EMR, we also condense the information into what is necessary to know about the patient in the specific context (i.e., the MDTM) (cf. [17]).

This visualisation of information aims at supporting the team communication at the MDTMs (cf. [16]). In our evaluation, the availability of information provided by the Clinical Journal proved an immediate gain; there was no dispute that more information can effectively be presented in the case discussions in order to improve the basis of the consensus decision. In fact, this is an outspoken desire of most specialists today. It is essential that they get quickly a shared understanding of each case, and the presentation of a patient overview will increase shared focus.

The specialists who participated in the simulated decision conference even expressed a need for more, and detailed, information to be presented prominently in the interface. For example, the comorbidity image in the middle of the patient overview offered a relevant summary, but did not give the specialist the level of detail needed. It appears that even though the comorbidity view provided a quick glance of the patient status, they still wanted more details directly in order to avoid further searching for the information (cf. [17]). Similarly, the organ view proved a good way of categorizing tumours, but it was not detailed enough for assessing resectability. Hence, the information presented at these meetings should both be quite detailed and expressed in an even more condensed way.

The specialists were also positive of the basic idea of the system, how it aggregates patient information and presents it in a consistent manner. It gives the specialists a “top-down-overview” of the entire case, and it provides check-lists of information to take into account. It evidently gives the participants in the decision conference support for the case discussions in a manner that has not been given before.

Interaction during Decision Conferences

Even though we were aware of the time-critical aspects of the decision meetings and that adding more information and interaction to the situation would affect their efficiency (cf. [12]), we decided to explore the possibilities of introducing collaborative tools to all participants. Our basic assumption, derived from previous observations, was that if a participant raises a question that no one immediately can answer, any participant would be able to quickly search for the information in the EMR. That is, all participants would be given the complete patient documentation in their hands, and have easy means of accessing it.

However, concerns were raised about which participants in the conference should have an individual device. The specialists agreed on that only a few key participants should actually have a device (the presenter and the chair), but they could be freely accessed by anyone. This concern seems to point to what roles and tasks the different participants have. Although most participants in the audience are from the same specialisation (surgery), they have quite different tasks to perform in the conference, and the system has to be designed to take that into account. Being active in the case discussions does not imply they need direct interaction with

the system; only a few roles have tasks that specifically require interaction with the system (presenter and radiologist). The other participants, who more or less listen to the discussions, do not have any formal requirements to interact with the system. It could be sufficient for them to have a “stripped-down” version of the system (with the possibility to read information, point to the images, but not to navigate) in order not to distract the shared focus. We did also notice a higher activity in the radiology view during the evaluation, when the participants pointed on the images. This confirms both our previous results [19, 24], as well as results reported by others [11, 22], of the need of collaborative pointing. Hence, the roles the participants have and the tasks they should complete during the MDTM also affect the interaction requirements.

Based on feedback from the evaluation, we have learned that interactive tools for these kinds of specialized meetings have to be carefully designed. Any system implemented in the meeting can only be useful if it does not disrupt the shared focus of the participants. In this context it would mean focusing on the display of case-based information to all participants at the same time, and offering specific interaction to support the tasks that certain participants must perform. Interaction might even be of different “levels”, as some participants interact more and others less.

Design Process

We have noticed a change of attitude towards the Clinical Journal, when going from paper sketches to a high-fidelity prototype tested in a realistic setting. Earlier considerations regarding how the system can be used at the decision conference have matured, for example, regarding who should use it and for what. Also, a more positive attitude towards the system in our earlier evaluations became more critical, especially regarding the interaction with the system but also regarding the purpose with the system.

As in all CSCW systems there was a concern of who should enter information into the Clinical Journal, because they did not understand how the information would be aggregated from the EMR. Our evaluation in the decision conference did not provide the respondents with the insight on how it could be used in other situations in the care chain. Therefore, they questioned the main idea with the system, whether it was a new EMR or quality register, and how the information would be gathered. The motif with the system is of course not to duplicate work, but rather aggregate and present information that is already in the EMR.

On the other hand, to some degree in this evaluation, but definitely in our previous studies [19], the specialists could also identify other situations in their work where the system (or parts of it) could be useful (e.g., at pre-op and surgery). More use of the system (in real situations) will probably spur more ideas and help find its natural part of the work processes. This is where we experience a dilemma when working in a time-critical and information dense domain

such as medical decision-making and MDTMs. Even though we have used a participatory design process over a long period of time, in order to truly explore the potential of a new system or tool it must actually be used for some time in the real setting.

Interaction Design in Complex Contexts

When trying to improve medical personnel’s interaction with patient information, we have learned that it is a matter of complex interaction design. The tools we design must work in a stable manner and add efficiency to current work processes, or they will not be used at all [20]. Therefore, we must abide to a participatory and iterative design process where the users are highly involved, as there is virtually no chance to design tools outside the medical context. But it is difficult to get hold of the users and construct proper settings for testing—it must be a realistic setting, but it cannot be the real situation. The only way forward is to include interaction design as a natural part of improving work processes and tools in today’s medical work. This calls for test environments with access to realistic patient data, where new interactive tools can be tested in as realistic contexts as possible. It is a matter of quality assurance of new information systems that are sorely asked for.

CONCLUSION

We have conducted a user evaluation, in a realistic setting, of a collaborative tool for visualisation of patient information in medical multi-disciplinary team meetings. The prototype has been cooperatively designed together with medical specialists in several iterations. Based on the results from the user evaluation, we have learned that much more patient information can be presented in the MDTMs than what is available today. But interaction with the information using collaborative tools in this complex setting must essentially be individually designed; it must support the different roles and tasks in the MDTM, and the process of reaching consensus decision on the cases discussed. A successful implementation of such a tool has a great potential to make the MDTMs more efficient by offering a case-based presentation and top-down overview of the individual cases. It also has a great potential to be an efficient tool along the entire care chain, by giving access to relevant and updated patient information when needed. It is however difficult to truly evaluate the system’s potential in isolated situations, as information is generated over a longer period of time, and activities in the specialists’ work are dependent on each other. As with all new technology to be used in health care, collaborative and interactive tools to visualise patient data have to be tested in realistic contexts.

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