Using Tablets for Hospital Rounds

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ABSTRACT
This paper reports our process of performing a contextual inquiry at the University of Washington Medical Center, finding a task that is currently paper based, the patient's Plan of the Day, and prototyping a digital version of it run on a tablet. We tested the prototype during rounds with an ICU team at the hospital and found that the basic concept was well received. With some further work all of our participants said they could imagine using the product in the future.

Author Keywords
Tablet; stylus; medical; contextual inquiry; rounds.

INTRODUCTION
Handheld devices seem to be everywhere these days, from in the hands of little children to the briefcases of business professionals. As we did a contextual inquiry at UW Medical Center to find out more about the way doctors and medical personnel interact with technology, we found a questionable absence of handheld devices. It seemed a lot of the work that was carried out during rounds was performed using either paper or desktop computers on carts. As the Nurse Practitioner we were following outburst "I don't understand why they don't just give us an iPad!" we knew this would be a good base for our project. And that is what this paper is about, digitalizing a small part of the hospital's currently paper based workflow and see what effects it would have on the team.

BACKGROUND

How the project was born
When we first started working on this project our goal was to prototype a touch less interface used in a medical setting. We both had a strong interest in how medical professionals interact with technology and started to think about the limitations that might restrict them from using their hands, such as prohibiting spread of diseases and infections or simply just not having enough hands to perform both the task at hand and to control the interface. One solution to the latter of the problems is to simply have an extra person do this according to verbal instructions from the doctor. We were interested in seeing if we during our contextual inquiry could identify such a task and develop a prototype that made it possible for one single individual to control the interface without the assistance from other personnel and without touching the device.

It turned out as we performed our contextual inquiry that the team we were visiting wasn't the perfect target for finding one of these, potential, touch less tasks. After observing a paper based task, each patient's "plan of the Day" (PoD), that seemed like it could be digitalized and also getting verbal requests for this, we changed our direction. Also the task seemed to fit well with previous work describing the following guidelines for tasks that are suitable to perform on a tablet. These include tasks that

• Consists of collecting information while wandering

• Entails smaller volume of data entry

• Does not require a large screen display to be presented well

• Supports a goal to keep the user current at all times

[1] All of these were incorporated in the paper based PoD.

RELATED WORK - HANDHELD DEVICES IN A MEDICAL SETTING
In 2011 Wagner et. al. performed a study in a 100 bed Midwestern hospital with the aim to introduce tablets in several areas of the hospital. The most relevant information that this study provided us with was the lessons learned. For example the tablets didn't turn out to be useful for the end users. The main reasons being; not having docking stations for when the tablets couldn't be held by the nurse or doctor in question, the stylus being difficult to use for some users, and that the "tablets did not match the work flow in the areas for which it was purchased and assigned." [2]

With base in this we found an article by Russ et al that identified some of the core characteristics of how electronic information affects workflow. The four main categories of desirable features of an Electronic Health Record (EHR) turned out to be that the system should be: trustworthy and reliable; ubiquitous;

effectively displayed; and adaptable to work demands. [3]

In 2009 a literature study was performed by Prgomet et al that showed that handheld devices held the characteristics to "positively impact rapid response, error prevention, information accessibility, and data management in healthcare settings". On the other hand their conclusion was that more work needed to address to which extent handheld devices provide benefits due to their mobility and if so how it can be used [4].

METHODS

Contextual inquiry

We decided to use contextual inquiry to gain an understanding of the participants workflow, and to identify a task we could target for a prototype. We chose contextual inquiry because of the gap in knowledge that we have in the medical domain. It would be hard to quickly come to a similar level of understanding about the workflow and needs of our participants using interviews or other less immersive techniques. Visiting the participants during their normal workflow also minimized the impact on their time, which is important as asking for additional time from medical professionals can be very challenging.

We observed our participants for four hours during rounds at the ICU. We focused on observing and asking about the participants' use of technology as they discussed patients and reviewed the latest information.

Participants

The contextual inquiry was done with an ICU team in the Pulmonary and Critical Care department at the University of Washington medical center. The team consisted of 12 individuals; the attending physician, several visiting physicians from other specialties (OB\GYN, anesthesia, pharmacists), medical residents, medical students, nurse practitioner, and nurses. There were 8 women and 4 men.

PROTOTYPE AND FIELD TESTING

After the contextual inquiry a web based prototype was developed. The basic functionality closely resembled the paper based PoD that is currently used at the hospital. Some changes we made was to make the initial form cleaner with option to add each prenamed field and new blank fields as you go instead of having them all there on start, opportunity to use both stylus and keyboard for input, and to be able to view the changes made to the document live from any other device connected to the same url.

During the test we used three different tablets, one Apple iPad, one Windows Surface, and one Google Nexus. The two first mentioned had styluses for input available during the test. The third was only used for viewing the live stream of inputs. We decided to provide the option to use a stylus as a complement to the on screen keyboard both because of a request from one of the attending physicians but also because studies have shown that medical professionals are very accustomed to using a pen and tasks are more accurately and faster performed when using a stylus compared to finger input [5]. This is true both for tasks performed when standing and walking, for sitting down there is no significant difference.

Figure 1. Tables used in Field Study. Top-left: Windows Surface. Top-right: Apple iPad. Bottom-center: Google Nexus

Participants

The prototype was used by a ICU team at the University of Washington Medical Center. The team consisted of 7 people, the attending physician, a medical resident, 4 medical students, one nurse practitioner and one intern. We also interviewed one of the nurses. This was a different team than the team we observed for our contextual inquiry, with the exception of the nurse practitioner that attended both sessions.

Procedure

After introducing ourselves and our prototype we had the participants freely try the prototype and give us their initial impression before performing the actual tasks that were ongoing during rounds.

During rounds we had the participants use our prototype as if they were actually taking notes for the real plan of the day. Per patient we had one person using the windows tablet taking notes and one or two

people that were more passively looking at the changes being made using a second or third tablet. We observed the usage both by watching the participants but also remotely via the url pulled up on our personal mobile devices.

After rounds we had a short focus group like session with semistructured interview questions followed by an individual questionnaire of five questions to evaluate the usage of the prototype. 6 people from the team filled in the questionnaire.

RESULTS

In general the response and feedback we got from the ICU team was very positive. Most members expressed a genuine interest in the idea and prototype both before and after the test.

Contextual Inquiry

During the contextual inquiry we followed the team on rounds for almost four hours, and saw how the participants exchanged a large amount of information verbally in that relatively short period of time. They also had two team members dedicated to using desktop computers (one for data retrieval and one for data entry) which were mounted on a computer cart which they pushed around with the team as it moved from person to person. They did this despite the fact that computers were available at nursing stations (where the discussion usually took place) and in every patient's room. Having a device logged in and at the appropriate context (patient and current results) was important enough to push around a desktop. During rounds, these desktops were the primary piece of technology used. While discussing the desktop computers with participants, several expressed a desire to be able to use a tablet PC, instead of the desktop.

One task that was also a key part of each patient discussion was writing down the "Plan of the Day" (PoD) for a patient. As the discussion was going on, one team member would capture the specific actions to take for a patient using a specific paper form. The form would also serve as a checklist of items to cover for a patient.

We did also observe some interaction with bedside monitors, but it was much more limited.

We observed a very information dense environment where we identified the risk of some information getting lost either orally or while dealing with papers. To be able to reduce that risk and digitalize part of that information seemed to be a desirable function for the team. Also a desire for using this for educational purposes was expressed by the attending physician. She wanted to be able to go back in time and view previous PoD sheets.

At the end of rounds we had a few minutes of discussion with team members who expressed a desire to have the plan of the day in an electronic format. Two team members specifically talked about the plan of the day and why they would want an electronic form.

The contextual inquiry encouraged us to move forward with the idea of the digital PoD sheet since that seemed to be what the need and excitement in the team was the strongest. We got explicit concerns expressed about the computer tables currently used and a wish for tablets and opportunities to be able to review data on mobile devices. "If I could view this on my phone that would be great!" - Doctor.

Field test

During the field test we observed some notable difficulties with the stylus when using the iPad and some smaller difficulties when using the Windows tablet. The latter were partially disregarded from the participants with excuses of bad handwriting. The typing was not used particularly much.

Interacting with the pre-named fields was different from person to person. Several of the participants didn't use the pre named fields at all, but continued to add blank fields continuously. Another participant pulled up all the prenamed fields, one of each kind, before starting to take notes, and was then a little frustrated because the blank fields appeared below these fields (on the paper version blank fields are above named fields).

The interaction with the patient list was limited. For the first patient one tablet lost its WiFi connection which resulted in the patient being created twice due to the page not refreshing.

Several participants asked for the ability to remove fields and/or erase text.

The attitude seemed to be positive and there were laughter as the updates showed up real time for the first time. Eventually they started using the page as a means for communication writing messages to each other. "It's fun. I mean that's good 'cause these things need to be fun too!" - Nurse Practitioner

Questionnaire

The results of the questionnaire showed that people in general thought our simple prototype worked relatively well.

The responses to the questionnaire were distributed according to the table below.

How difficult was it to:	1 Not difficult at all	2	3	4	5 - Very difficult	Did not try that functionality
Write using the stylus	2	3	0	0	1	0
Write using the keyboard	1	1	0	1	0	3
Check the checkboxes	5	1	0	0	0	0
Navigate between patients	1	0	0	0	0	4

Table 1. Questionnaire responses.

For the question "Would you consider using a similar system if it was refined?" 6/6 answered "Yes".

Additional free form comments we got from the questionnaire were: "Being able to write outside of the boxes would be key", "Better interaction with the checklist", "Live updates helpful", "would be great to be able to see ORCA [currently used medical software] on the tablet too (for rounds)", "Be able to write anywhere on the screen"

DISCUSSION

In general this project got us thinking about a few things; first - what would be the next steps in implementing and incorporating this prototype into the hospitals current workflow, and second - from a value sensitive design perspective, what other stakeholders are there to consider when making this kind of product. Also we wanted to discuss in what ways we could have changed our process in order to improve our results.

FEEDBACK AND NEXT STEPS

Refining prototype

During our field test and the following focus group we got good and relevant feedback from the team about what improvements that could be made to the prototype. First of all they wanted to treat the form even more as a paper, being able to write anywhere on the form would allow then not only to check checkboxes but also to scratch out and make notes if something in the checklist doesn't apply for that particular patient.

Furthermore they wanted to have the fields more like the ones on the paper version, so that they did not have to push a button to make each field appear, they treated it more like a checklist and wanted every item to be there every time. So our assumption that making the form more simplified and customizable would be helpful turned out to be the opposite.

Additionally there are some other changes that we believe are necessary to make in order to improve the usability of the document. These changes are more based on our observations than explicit feedback from the team.

First, the input method for each form should be unified to one single button for the whole page, it makes it easier to find and doesn't force the user to choose an input method for each field. Also we'd like to use an icon instead of a word as the word "write" is a bit ambiguous, it makes more sense to have an icon showing a pen, and correspondingly replace the word "type" with a keyboard icon.

Second, the way of managing patients in the system needs to be looked into. Since this is out of the scope for both this project and this paper we will not discuss in particularly close detail. Observed is though that using the build in "back button" in a browser for going back and forth between the list of patients and the patients details makes the user hesitant as no feedback is given whether the document is saved or not. That's why we in the second design iteration added a simple "Save and Quit" button at the bottom of the form.

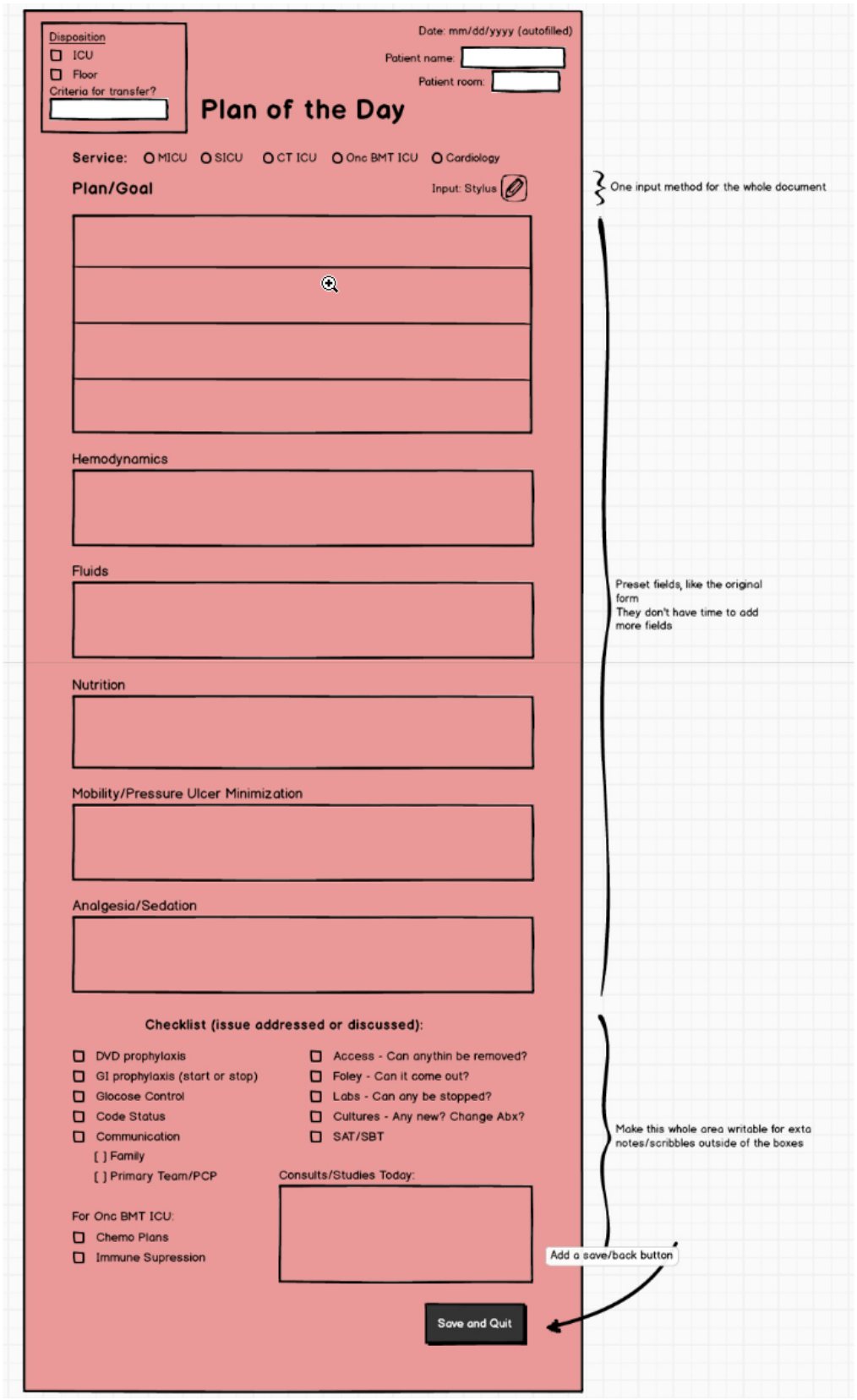

Figure 2. New form after feedback

Integration with current workflow

As we develop the prototype into a finished application continued work with the team is required to learn how to best use a digital form in their current workflow. Since earlier research has shown that the integration in the current workflow is one of the hardest parts, (Wagner et al 2011) more energy needs to be put into this. What, if anything, would change from the current workflow? Is it positive or negative changes? How can the tablet be used to its full advantage? What about other users, like patients, caretakers, or nurses? How would their experience be changed? In terms of design one need to make the system "trustworthy and reliable; ubiquitous; effectively displayed; and adaptable to work demands" [3]. All these aspects need to be addressed in order to successfully integrate a new technology at the hospital.

Integration with existing technology

As part of the full deployment of the application, the form would become more useful if it is integrated with the current electronic medical record (EMR). As an example, one of the team members brought up the point that if a patient is currently intubated (information which could be pulled from the EMR) then the form should show an additional checklist item to make sure that the team discusses that point.

Deploy as a finished application

Our hope is continue to work with the team and also with a health IT vendor, Caradigm Inc. to develop a finished application based on the prototype. This would then be deployed at the hospital and be available for use.

VSD - Direct and indirect stakeholders

As we first observed the participants at the ICU and discussed what they wanted, certain values began to emerge from their comments including: patient safety/human welfare, efficiency, and teamwork. While the ICU team is foremost focused on the care of the patients, they have a secondary goal as a teaching hospital to train the medical students and residents. It seems useful to consider the same group of individuals as a distinct stakeholder, members of the medical school. The value that group is most focused on is education. The physician that first invited us to come specifically called attention to the fact that she would use the saved PODs as an educational tool.

Beginning between visits we began to consider the values of indirect stakeholders. Patient caretakers (often the patient's family), nursing staff, hospital IT department, future students, and the hospital legal team. While onsite we were able to briefly discuss the prototype with a nurse to get some idea of what they value. That nurse seemed to value efficiency, as she described a digital POD something she would not look at and unnecessary.

Direct Stakeholders	Value	Impact
ICU team	patient safety/human welfare	Positive, the digital version of the POD can be a more intellegent checklist helping to ensure all items are covered
	efficiency	negative. Not as fast as simply taking quick notes on a piece of paper
	teamwork	positive, makes POD more available for review during and after rounds
	privacy	negative, makes POD more available and likely to be seen by someone not intended
medical school members (also ICU team)	education	positive, allows old PODs to be saved for future teaching

Table 2. Direct Stakeholders

The main values in conflict for the direct stakeholders seem to be efficiency vs. patient safety. If we can keep the application working smoothly without much impact to current workflow or efficiency we should have something they will want to use.

Indirect Stakeholders	Value	Impact
Patient caretakers	communication	positive, POD can be viewed more easily
	privacy	negative
nursing staff	efficiency	negative (at least from our anecdotal conversation)
Hospital IT department	stability?	negative, new application to support
Hospital legal team	reduce liability	negative
Future medical students	learning	positive

Table 3. Indirect Stakeholders

What we should have done better

As mentioned our original goal was to identify a task to accomplish with a touch free interface. While this goal was communicated to potential participants both orally and written it was done before the actual visit and then not directly to all the participants which we observed in our first visit. When we arrived there was no time to introduce ourselves or our purpose. The result was that the participants did not have a clear idea of our purpose. Much more communication and more clear communication of the goal of our observation needed to happen. Another potential issue is that it is common for other medical professions to come and observe the work of staff at the University of Washington. Therefore there is a preconceived notion in the staff of the purpose of an observer which is quite different from our purpose. We needed to overcome that basic assumption of why we were there.

While the ICU had the potential to be a good place for observation of procedures and tasks, perhaps other areas of the hospital would have been better. The ICU was chosen mostly due to availability. More time or relationships with other medical staff may have led to a observing a different team.

After spending time with the team, even just once, our purpose became much clearer to participants and an eagerness to work with us was expressed. We should have planned an initial visit to establish a relationship and describe our project.

CONCLUSION

Doing contextual inquiry at a hospital is hard. Mostly because of the limited knowledge we as designers/developers carry about the routines and practices that are current in the environment, it votes for more time in the field than possible other inquiries would need. Also getting in contact with medical professionals that are willing to help out with this kind of project is tricky mostly because the are in general very busy. Once a relationship was established things became easier though. We managed to successfully test our prototype and get feedback essential to making design improvements enough for the next iteration of the process. Clear is that the digital form needs to function more as a checklist and the users need to be able to use the stylus to write anywhere in the document, even outside of the textboxes. The next step is to make suggested changes and present the prototype to Caradigm Inc to see if they want to move things forward.

ACKNOWLEDGMENTS

We thank the medical professionals of the Department of Critical and Pulmonary Care at the University of Washington Medical Center for taking part in the experiments of this study; since this was during their ordinary shift it was definitely a strain on them.

REFERENCES

1. Jøssund, L. (2006). Towards Handheld Mobile Devices in the Hospital: Suggestions for Usability Guidelines. (Student paper). Norges teknisk-naturvitenskapelige universitet Institutt for datateknikk og informasjonsvitenskap.
2. Wagner, J, Dawn L.M., Proceedings of the Human Factors and Ergonomics Society Annual Meeting September 2011 vol. 55 no. 1 818-822.
3. Russ A. L., Saleem J. J., Justice C. F., Woodward-Hagg H., Woodbridge P. A. and Doebbeling B. N., Health Informatics Journal December 2010 vol. 16 no. 4 287-305.

4. Progmet M., Georgiou A., Westbrook J.I., J Am Med Inform Assoc. 2009; 16:792–801. DOI 10.1197/jamia.M3215.
5. Holzinger, A.; Holler, M.; Schedlbauer, M.; Urlesberger, B., "An investigation of finger versus stylus input in medical scenarios," Information Technology Interfaces, 2008. ITI 2008. 30th International Conference on , vol., no., pp.433,438, 23-26 June 2008.
6. Holzinger A., Searle G., Peischi B., Debevc M., International Joint Conference, ICETE 2011, Seville, Spain, July 18-21, 2011, Revised Selected Papers pp. 156-167