Mediating Interaction Between Healthcare Professionals and Patients with a Dual-Sided Tablet

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Abstract. We present and evaluate a functional prototype of a dual-sided tablet, where the back of the tablet presents complementary information to a patient during a medical consultation. Handheld tablet computers are nowadays part of the standard toolkit used by healthcare professionals, however, rather than supporting the interaction between the two parties, the device usage may create a communication barrier. Evaluation of the dual-sided tablet by healthcare workers and via an on online survey revealed that both groups considered the concept beneficial. Display of information on the medication, treatment timeline, and vital measurements (e.g. blood pressure, heart rate and temperature) on the patient side of the tablet were most valued. Additionally, patients felt increased assurance that their basic information was correct.

Keywords. Doctor-patient interface; health informatics; hospital information systems; electronic health record; dual sided display.

1 Introduction

The interface between healthcare professionals and patients is critical in establishing a fluent communication channel between the two parties. In addition to the exchange of factual information, it influences the satisfaction of patients, and also clearly has an impact on the success of the medical care itself. For example, prior research has investigated the benefits of patient information displays and micro-explanations [12,13]. Today, handheld tablet computers, such as Apples iPad, have become a daily working tool for many healthcare workers [2,9]. In US hospitals 70% of physicians use smartphones or tablets as part of their daily working tools [14].

With the exception of repackaging to improve robustness or hygiene aspects, the majority of devices used are standard consumer devices, largely driven by their low price and familiarity of use. However, there is room to improve the human side of the technology, and optimize its design for situations where the healthcare professional is interacting with patients. With this motivation, we aim to create and evaluate a concept aiming to improve the patient experience by addressing the design of tablet computers used by healthcare professionals in a hospital environment. Specifically, we aim to address the challenge related to the device creating a barrier between caregiver and patient, de-personalizing the interface, and the patient's feeling of not knowing what is happening whilst the doctor/nurse works with the tablet.

Fig. 1. The dual-sided tablet used in a hospital context. The front display shows electronic health record information, whilst the rear display provides the patient with visual information to support the consultation process.

To address these challenges, we propose a dual-sided tablet, where the back of the device, i.e. that typically facing the patient, also contains a display. Thus, it can provide supporting visual information to the patient during the consultation (Figure 1). This work extends the previous introduction of the concept of a dual-sided tablet a demo [1], by reporting on an evaluation by medical professionals and potential patients.

2 Related Work

2.1 Use of Tablet Computers in the Hospital Domain

Prior art has studied the specific uses of tablet devices by hospital doctors, for example [10] reports that 30% of the clinicians in their study used tablets for sharing results with patients. The use of tablets to access Electronic Health Records (EHR) in the patient interface is highlighted as a core use case [2, 9]. Considering the use of tablets devices in the doctor's examination room, [9] concludes that the use of tablet computers was perceived positively by most patients. Based on the ubiquity of tablet device usage in today's hospital, it is well-motivated to try to improve the user experience in situations where the healthcare professional is interacting with the patient. Whereas the research on mobile technology usage in hospitals has been quite extensive, the concept of dual-sided tablets has not been previously examined.

2.2 Dual Display and See-Through Devices

Although a single-sided display is the default condition when interacting with computers, research has also addressed devices that include some form of display on two sides, and also some commercial examples exist. However, the examples are outside of medical domain. For example [6] present an implementation of a foldable display

that may be configured such that it provides displays on front and back. Here, the focus is on the foldable interaction aspects rather than application contexts.

Considering touch input on one side of a device creating output on the reverse side, Lucid Touch [11] provides some insights, although with a totally different target than in our case. Devices with displays on two sides have been demonstrated in context of social use [3, 4]. In [3], a display attached to the back of the mobile phone shows which application the person is at the time using, and Kleinman et al. [7] have experimented with a laptop integrating a back-of-the-cover screen for self-expression with images and text. On a larger scale [8] present multi-user interaction on a 2-sided fog screen. The benefits of dual-sided see through displays for collaborative work are discussed by [5], concluding that it is an essential feature that each side of the display can display different content – a feature integrated into our concept. In the commercial sphere, Yota Devices (http://yotaphone.com/) produce a phone device with an e-ink display on the rear of the device, creating a dual display device. For example, when the camera application is active the rear display shows the text "smile" to the photograph's subject.

3 Dual-Sided Tablet Prototype and Evaluation

3.1 The Concept

Although the related work describes many positive sides of tablet use in the doctor-patient context, there is still further potential in improving the user experience and better mediate the communication between care personnel and patient. For instance, interaction ergonomics, trust, information visualization, and avoiding de-personalization of the patient experience can be better addressed. Currently, the patient is faced with the blank back of a tablet, whilst the caregiver attends to the tablet interface rather than the patient.

The front display of the dual-sided tablet is the healthcare professional's view. We envision this to be the current content used by medical professionals such as access to Electronic Health Record information and detailed data from the hospitals ICT systems. Additionally, the professional's view contains controls for the information that appears on the patient's view, e.g. a button to enable visibility. In this way, the healthcare professional is able to visually support his consultation with the patient.

3.2 Prototype Implementation

As a prototype implementation, we utilized two 10" Android tablets attached back-to-back in a 3D printed containing case we designed specifically for the purpose. Each tablet ran a custom developed Android application. The healthcare professional's view was implemented as a single page EHR type content with buttons in each section to switch on or off the display of the corresponding patient view on the opposite side of the tablet. As an extra feature, when the nurse or doctor views x-ray images and charts, we added the possibility to draw annotations on top of them, the result being also displayed on the patient's display. The annotation feature aimed to support

the verbal consultation conversation e.g. by highlighting parameters as they are discussed. The upper display was interactive, i.e. a touch screen, and the interconnection between the two devices was made using Bluetooth. Our initial implementation and its usage are illustrated in Figure 1.

Fig. 2. The six patient side screens evaluated in the focus groups and survey.

Six different patient views were implemented (Figure 2). These were selected to give a range of information types, from basic information, such as the patients' name and condition to information requiring more explanation, such as charts and x-rays.

3.3 Evaluation

As understanding the context of use is a critical part of identifying the potential value or problems of the dual-sided tablet, we create a video demonstrating its use in a hospital context. The video first showed the current experience using a traditional tablet and then the same scenario using the dual-sided tablet. Stills from the video are shown in Figures 1 and 2. The video and static images of screens from the dual-sided tablet prototype (Figure 2) were then used as source material for focus group sessions with healthcare professionals and an online survey. Additionally, the interactive prototype was presented in the focus group.

4 Results

### 4.1 Focus Group with Healthcare Professionals

We conducted four focus groups with altogether 25 participants (female = 22, male = 3), and 4-6 participants in each session. The participants were nurses, or student nurs-

es close to graduation, who already worked closely with patients in a hospital setting. All 25 participants had previous experiences with electronic patient care records or other similar systems, 25/25 owned a smartphone and 16/25 a tablet.

The implemented demo and the video showing the use in a (simulated) hospital environment were shown. After viewing the video, the participants were directed to discuss each of the patient's screens in turn and asked to evaluate the various features presented in each. A researcher acted as moderator and the sessions were video recorded for later analysis.

Providing the patient with visibility of what the caregiver's actions was the main topic raised in the focus group discussions, one participant stating: *"I think it would be nice if the patient could see what their caregiver is doing. Then they don't get the feeling that they're hiding something or googling for symptoms"* (#9, female, 22 years). The nurses saw the most useful aspects to be, the capability to show and annotate X-Ray images, to show vital information and to show medication information. Providing general information about patient's name, medical condition and doctor's name was seen as less useful.

Overall the visual representation of information was viewed positively with one participant commenting: *"The staff is more present with this device. Also the information is visual! Many people understand visual information better than spoken information."* (#12, female, 24 years). Responses on the general usefulness of the concept and expectation of its future were clearly positive, Figure 5. Overall nurses considered the dual-sided tablet as a valuable addition to the daily workflow and for improving the clarity of information delivery to patients.
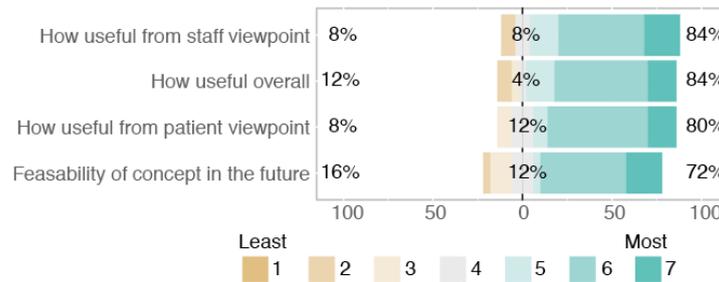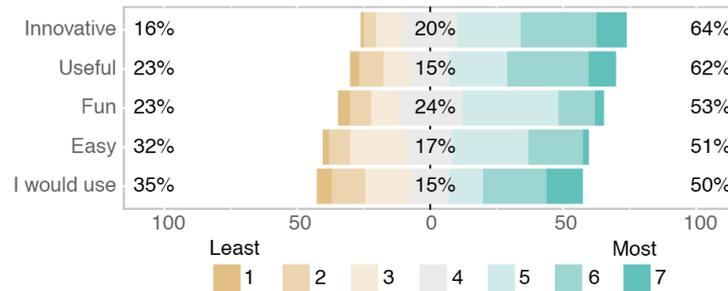

Fig. 3. Responses to the concept by nurses (n = 25). Percentage values indicate percentage of responses on negative, neutral and positive sides respectively.

4.2 Online Survey.

With an online survey we aimed to gain the viewpoint of average people who would potentially be patients receiving care in a hospital. The survey the participants viewed the same concept video as used in the focus group sessions, and then proceeded to rate and give feedback on each of the features in concept. After removing 15 incomplete responses, the survey received 81 complete responses (67% female, 33% male), which were further analyzed.

Of the participants, 90% resided in [country removed for review], 96% owned a smartphone and 42% owned a tablet computer device. Considering their experience as a patient, 48% had been a patient in a hospital ward, 75% had experience a consultation with a doctor, and 43% had accessed their electronic medical records in some way.
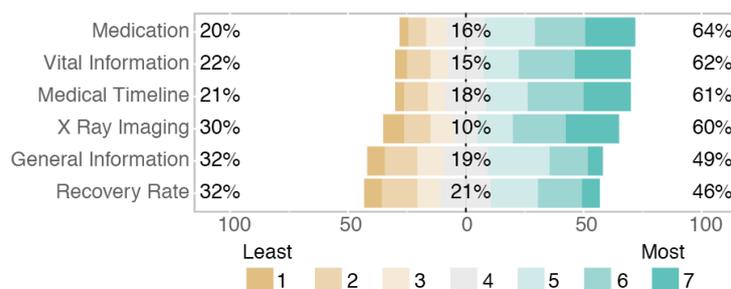

Fig. 4. Rating scale responses from the online survey on the overall opinion of the dual-sided tablet concept (n = 81). Percentage values indicate percentage of responses on negative, neutral and positive sides respectively.

Participants' feedback on a rating scale (figure 6) indicated the concept was considered *innovative* and *useful* with 65% and 62% of responses being on the positive side. Many participants noted the potential to enhance the communication channel between the doctor and patient, *"...engaging patients in real-time interaction with healthcare experts."* (#66, male, 26 years) and, *"Great idea! It offers more interaction and more comprehension for the patient. It also allows the doctor to read the information and maintain contact with their patient during the meeting."* (#74, female, 23 years). Potential problems with the concept were also noted, particularly related to the ergonomics of the patient viewing the content, *"The position of the patients' screen makes it difficult to read because of the typical way of holding a tablet."* (#48, male, 22 years)

Considering importance of the patient-side content (figure 7), participants felt that information on the medication prescribed was the most valued, with 64% rating this positively. In the freeform comments the participants commented on the legibility of the information: *"The medication information is given clearly and the purpose of each medication is explained well. Simply an efficient and a clear way to show information."* (#94, male, 26 years) Other participants commented on the reassuring effect the information about medication has on the patent: *"It answers a lot of questions, it's reassuring for the patient."* (#50, female, 22 years).

The value of the views showing vital information, medical timeline and x-ray imaging were all rated similarly with between 60% and 62% of participants giving rating on the positive side. The vital information view provided an overview of the current values basic measurements such as blood pressure, heart rate and temperature, together with an indication of the normal range. Generally, participants considered being able to read the information in addition to hearing it from the doctor was beneficial, *"It's good to have an overview of the vital information, so the patient can read it themselves."* (#75, male, 28 years). Considering the visualization, one participant

commented, *"The colors help the patient understand what's happening. What is wrong and what is right."* (#50, male, 22 years).

Fig. 5. Rating scale responses from the online survey on the usefulness of each patent view (n = 81). Percentage values indicate percentage of responses on negative, neutral and positive sides respectively.

The medical timeline, indicating the treatment schedule in a vertical timeline, was seen as an understandable and a useful way of representing information about the hospital visits. Participants commented, e.g., *"It's great to see the whole process of treatment, and relaxing to see that there is some life after surgery."* (#1, female, 40 years). Although generally positively received the x-ray view also received ratings on the negative side, here participants felt that the visual information was not useful without further visual or verbal explanation, e.g., *"It would be better if there was some analysis with the x-ray"* (#17, male, 24 years) and *"This requires the doctor's spoken explanation in addition to the picture."* (#1, female, 40 years). The general information view aimed to reassure patients that their basic information was correct, e.g. that they were being treated for the correct illness, and this was commented accordingly: *"I think it's important to see your own name, so you can make sure you are the correct patient, and the doctor's name. These create safety."* (#2, male, 27 years). The concept also opened possibility for the patient to see new types of information: *"Never seen a recovery visualized before"* (#73, male, 23 years).

Discussion and Conclusion

To the best of our knowledge we present the first evaluation of a functional prototype of a dual-sided tablet for use in the clinical environment. Both medical professionals (n = 25) and potential patients (n = 81) considered the concept as useful. Communication of information that is difficult to understand purely verbally, such as medication names, numeric information and the treatment timeline, was identified as particularly enhanced by the visual support of the dual-sided tablet. Both medical professionals and potential patients considered information on medication, treatment timeline, and vital measurements (e.g. blood pressure, heart rate and temperature) as the most useful. From the patient's perspective, the dual-sided tablet also brought assurance that

their basic data was correct, and offered a possibility to see new information types visualized.

We acknowledge that our work is limited by the facts that it is not carried out in a real clinical environment, and presents feedback from only one type of medical professional. As future work, we plan to extend our work and address these limitations.

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