A HEALTH INFORMATION SYSTEM THAT EXTENDS HEALTHCARE PROFESSIONAL-PATIENT COMMUNICATION

Prototype

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Abstract

Communication between healthcare professionals and patients as part of the therapeutic process is often restricted to short, episodic face-to-face encounters within healthcare institutions. The absence of a continuous communication process that extends the face-to-face encounter to include the therapeutic process outside the institution limits the support and guidance healthcare professionals can provide, and in turn negatively affects patients' adherence, health outcomes, and overall healthcare costs. This paper introduces the notion of interaction-templates that structure communication between healthcare professionals and patients along the entire therapeutic process. The presented health information system (HIS) prototype implements a follow-up and guidance process triggered by the face-to-face encounter, combining predefined interaction-templates and dialog functions enabling individual, situation-dependent communication. Analysis of data generated with the prototype will provide a better understanding of the structure, form, and content of communication in HIS that extend healthcare professional-patient communication.

Keywords: Health Information System, Communication, Interaction-Templates, Therapeutic Process.

1 Problem Statement

Communication between healthcare professionals and patients is an integral component of the therapeutic process and a major determinant of patients' satisfaction, adherence, and health outcomes (Street et al., 2009; Ong et al., 1995; Haskard-Zolnierek and DiMatteo, 2009; Stewart, 1995). Communication, however, is to this day often restricted to short, episodic face-to-face encounters within institutional spaces such as hospitals, physicians' practices, or pharmacies. Those parts of the therapeutic process that are outside the institutional space – when patients are on their own – currently lack any form of structured communication. The communicative demands of a continuous therapeutic process ranging from the inside and extending to the outside of institutions therefore cannot be met by intra-institutional face-to-face encounters alone. The absence of a continuous communication process limits the support and guidance healthcare professionals can provide, and in turn negatively affects patients' adherence, health outcomes, and overall healthcare costs (Haskard-Zolnierek and DiMatteo, 2009; DiMatteo et al., 2002). Increasingly shorter consultation times and earlier discharges due to health systems' cost pressures add to the problem (Bitzer et al., 2013).

Whereas the impact of communication and interaction *within* institutions has been extensively researched and has resulted in a variety of guidelines supporting healthcare professional-patient communication (Ford et al., 2003; Smith et al., 2000; Greenhill et al., 2011), the situation differs for extra-institutional communication between patients and healthcare professionals. Here, research has analyzed the effectiveness of telemedicine (Ekeland et al., 2010), web messaging tools (Liederman and Morefield, 2003), email (Leong et al., 2005; Atherton et al., 2012), or information prescription (D'Alessandro and Kreiter, 2004; Ritterband et al., 2005). None of these studies, however, pays tribute to the fact that communication itself, as an integral part of the therapeutic process, must be a continuous and structured process in its own right. Although, information technology has an enormous potential to overcome current conceptual and practical limitations (Agarwal et al., 2010), the prerequisite for any successful design and implementation of health information systems (HIS) in the therapeutic process, is to analyze and understand the needs, structure, form, and content of a continuous communication process triggered by, and extending beyond the face-to-face encounter.

The goal of the present research therefore is to develop a HIS that is based on the conceptual approach that communication must be an integral part of the entire therapeutic process, starting within the institution and including the outside, or extra-institutional space. The HIS introduces the notion of *interaction-templates* that structure communication and with it the therapeutic process, and a *dialog function* that enables individual, situation-dependent interaction between healthcare professional and patient. This enables the healthcare professional to provide structured support beyond the face-to-face encounter and enables the patient to approach the healthcare professional when situational problems arise. The remainder of the paper is organized as follows. First, the research approach and the design objectives of the HIS prototype are introduced. Second, the prototype is described in detail. Finally, it is outlined how the prototype and its evaluation aim to contribute to theory and practice.

2 Design Science Approach and Design Objectives

Following the design science research paradigm (Gregor and Hevner, 2013; Hevner et al., 2004; Peffers et al., 2007), a HIS prototype was developed using an iterative development approach consisting of multiple build and evaluation cycles. The prototype has been developed in close collaboration with twenty-one Swiss pharmacies. Pharmacies contributed through numerous interviews, surveys, and several prototype evaluation phases over the duration of two years. The pharmacist was chosen as an exemplary healthcare professional, (1) because the pharmacist is usually the last healthcare professional who is in contact with patients starting therapy, and (2) because economic reasons favor the pharmacist as a guide throughout therapy over the physician. We assume that the prototype itself and the analysis of communication are transferable to other healthcare professional-patient settings.

The main goal is the development of a HIS that extends communication over the duration of therapy, starting with the face-to-face encounter inside the pharmacy. Previous research in this context has derived design principles for Pharmacist-Patient Health Information Systems (Volland et al., 2013) and proposed as well as applied genre analysis methods to design and evaluate communication in HIS (Volland et al., 2014). The present prototype paper builds upon this research and focuses on the introduction of the core design objectives that emerged during the design cycles and were implemented in the presented prototype.

The first design objective is the development and integration of *interaction-templates*. Interaction-templates consist of a number of joined single communication items. Depending on the respective indication or drug, predefined interaction-templates are selected by the pharmacist during the face-to-face encounter. The need for the integration of pre-defined communication evolved from the typically short interaction between pharmacist and patient, which usually does not allow for the creation of individually tailored follow-up during their personal encounter. Interaction-templates are the principal

tool to structure extra-institutional communication as they define at which time points the patient automatically receives a specified communication item from the pharmacist. Examples are additional health information on the second day, the request to send a photo documenting the healing process on the fifth day, and a final success-feedback on the tenth day. Predefined interaction-templates are indication-specific, and allow for the generation of comparable data sets that become part of a continuous optimization cycle.

The second design objective is to enable spontaneous, unstructured communication. Whereas predefined interaction-templates provide a principal framework that structures communication for defined patient groups, individual patients within these groups will have different situational demands that escape pre-structured communication. Predefined interaction-templates are therefore complemented by a *dialog function* that enables spontaneous, situation-dependent communication and feedback and therefore enables pharmacist and patient to react to the circumstances that emerge throughout the therapeutic process.

In addition, the need of seamless integration of the HIS into the routines of pharmacist-patient interaction emerged as a core design objective. In order to find acceptance, the HIS must be integrated into the very traditional interaction patterns of pharmacists and patients. With time being a critical resource, selection, as well as instantiation of the interaction-template must improve face-to-face interaction, and act as a bridge from physical to virtual communication. Disturbing existing interaction patterns, inefficiencies, as well as perceived breaks in the interaction pattern across the physical-virtual boundaries would undermine any chances of integration and usage of the HIS.

3 Description of the Prototype

The HIS prototype consists of three clients for three different user roles and a server that synchronizes and logs the usage data of the clients. For management, storage, and access of the data NoSQL databases are used on the server and locally on the clients. Data is transmitted in JavaScript Object Notation (JSON) over the Hypertext Transfer Protocol Secure (HTTPS). The first client is a tablet-PC application that allows communication and monitoring of patients by *pharmacists*. The second client is a smartphone application used by *patients* that guides them along the prescribed interaction-template and allows for communication with the guiding pharmacists. The current target platform for the pharmacists' and the patients' clients is Apple iOS version 6.1. The implementation was done in JavaScript using Titanium (http://appcelerator.com), consisting of a software development kit that provides the necessary tools, compilers, and application programming interfaces to build for different target platforms. The third client is a web application (PHP) that enables *editors* to configure, improve, and share interaction-templates. Figure 1 provides a high-level overview of the different roles in, and components of the HIS. These are described in greater detail in the following.

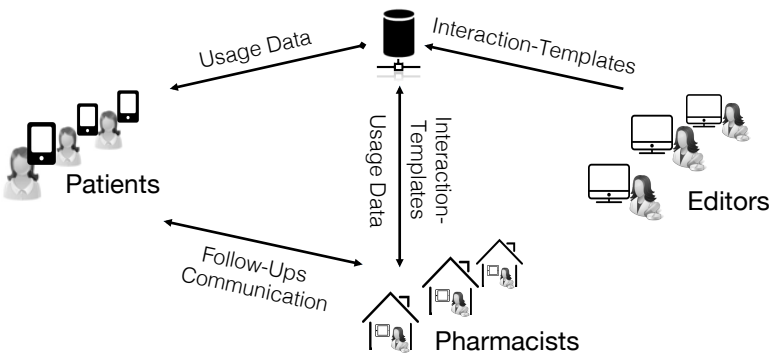

Figure 1. HIS Overview: tablet-PC-app for pharmacists, smartphone-app for patients, web-interface for editors, and a backend based on Titanium (http://appcelerator.com).

Editors can create interaction-templates with the web application. An interaction-template consists of a description of a situation and a list of communication items. The situation defines when a specific interaction-template can or should be used. This may refer to the prescription of a specific drug or a specific indication. The list of communication items holds the interactions that structure the communication between pharmacist and patient. Each item has a time relative to the face-to-face encounter, a communication-type, and a communication-text. So far, interaction-templates for *antibiotics*, *nutrition-counseling*, *pain-therapy*, *tick-bite*, and *head-lice* have been created by editors. Table 1 provides a condensed example of the interaction-template *tick bite.*

#	Date/Time	Type	Communication text that is displayed to the patient
1	Directly	Message	Dear Mrs. Jones, you had a tick bite. Please note down the date and location of the bite. In the next days you will receive messages that remind you to check the bite. This is important to early recognize a potential infection.
2	Day 3 9:00	Photo-Feedback	Dear Mrs. Jones, please send me a photo of the bite. This enables me to track the healing progress and advice you accordingly.
3	Day 4: 9:00	Message	Dear Mrs. Jones, please check the next days if you have any symptoms of a flue like fever, headaches, or tiredness. This could be caused by an infection through the tick bite.
4	Day 28 9:00	Success-Feedback	Dear Mrs. Jones, your tick bite has occurred four weeks ago. Is the bite completely healed?

Table 1. Tick-bite interaction-template.

In addition to the provisioning of information to the patient in form of personal *messages* or rich-formatted mobile *webpages*, the following feedback items, where the patient is requested to provide a status update, have been implemented: Feedback on *therapy-progress* (scale from "significantly worse" to "significantly better"*)*, *pain* (pain-scale from 1 to 10)*, photo,* several *physiological parameters* (e.g. blood pressure, pulse, or body temperature), as well as final *therapy-success* (binary indicator).

Pharmacists use the tablet application during the personal interaction with the patient and to communicate with the patient during the time of the follow-up. The main user interface is illustrated in Figure 2. The presented view shows the current list of patients of a particular pharmacy. Patients with the most recent communication appear on top of the list with an indicator that shows the number of new messages and feedback documentations. The list of patients can be searched and filtered for different variables like patient's name, name of the guiding pharmacist, or medication. By clicking on a particular patient, more detailed information is revealed. This includes personal information like the name, gender, age, and the name of the associated pharmacist. The predefined communication items are visualized in the form of a calendar. Patient "Jones" in Figure 2 was asked for photo-feedback on the 1st of December and responded with a photo of her affected skin. The pharmacist can review the photo and mark the communication item as *checked*. In case the pharmacist wants to respond to patient "Jones", she can start an ad-hoc-communication with the patient (this is visualized in Figure 4 in the Appendix). This can be a simple text message but also the previously introduced communication items like requesting another photo or feedback on a pain-scale from the patient. In addition, she can also arrange for a face-to-face follow-up appointment with the patient in the pharmacy. The communication items to the right show the subsequent items that patient "Jones" will receive until the interaction-template is completed on December 9.

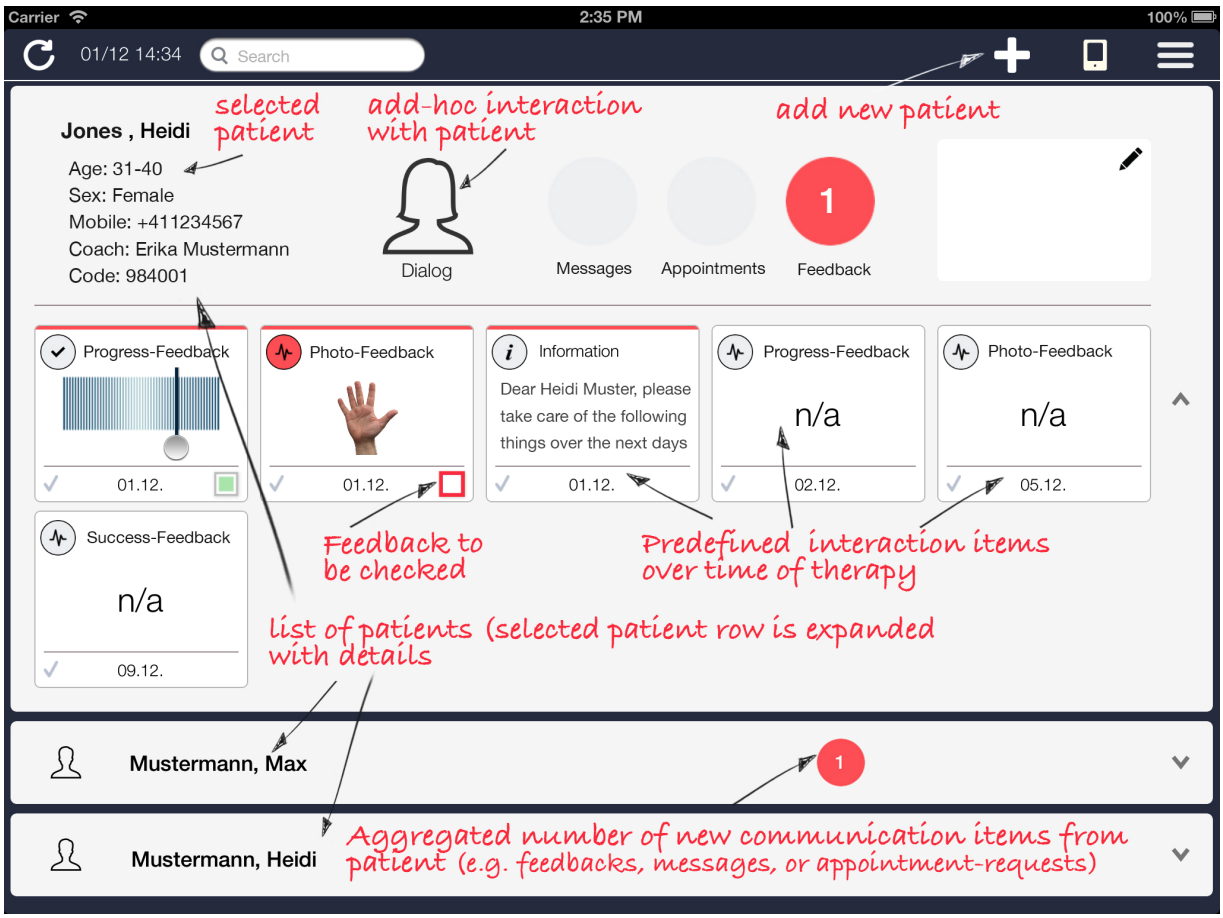

Figure 2. Pharmacist's user interface main screen on a tablet-PC.

During the face-to-face encounter in the pharmacy, pharmacist and patient decide on a specific interaction-template. The name, mobile phone number and the guiding pharmacist are recorded. The respective interaction-template is selected from a list of available templates, which is automatically synchronized with the backend and thus always current. Alternatively, the pharmacist can create a new interaction-template or customize one of the existing templates to the particular patient's needs by adding or eliminating communication items.

Finally, the patient receives a personalized access code created by the system and noted down on the pharmacist's business card. In addition, the patient receives the code and the download link to the app via an automatically generated SMS message.

After the patient has received the code and entered it into the smartphone application, the main screen as illustrated in Figure 3 is shown (more screens are illustrated in Figure 5 in the Appendix). The name of the guiding pharmacist is displayed at the top. The remainder of the screen visualizes the interaction-template in form of a circular path around the pharmacist. The circle is scaled according to the specified follow-up time – in the illustrated case eleven days. In Figure 3, patient "Jones" is on the first day in her follow-up as indicated by the green progress bar. Red symbols represent communication items that need to be accessed by the patient. Grey symbols represent future communication items. Communication items that were already accessed and completed by Mrs. Jones are replaced by a checkmark symbol. The ad-hoc communication dialog with the pharmacist is started by clicking on the pharmacist symbol in the center of the screen. Unread ad-hoc messages by the pharmacist are indicated by a red speech-bubble. Using the buttons at the bottom of the screen Mrs.

Jones can book appointments and ask questions. Whenever Mrs. Jones receives an ad-hoc or predefined communication item, she is reminded by a push notification.

Figure 3. Patient's user interface main screen on a smartphone.

All actions performed by the different roles within the HIS are logged on the server, starting from the addition of a patient to the HIS by the pharmacist, and including all communications – predefined and spontaneous ad-hoc communications. All actions are logged with corresponding senders, communication-types, and timestamps. An analysis of the data will show which predefined communication items are accessed and used by the patient and the pharmacist and which are not. Analysis will also show patterns of spontaneous communication that can be turned into predefined communication and further improve the interaction-templates. To provide a specific example: If a number of patients asks a particular question at a specific time point, the contents will become part of the predefined interaction-template, thus freeing resources from the pharmacist. In addition, patient and pharmacist automatically receive a survey aiming to evaluate their satisfaction with the face-to-face encounter (right at the start of the follow-up) and their satisfaction with the follow-up using the HIS (after the follow-up has been completed).

4 Conclusion and Contribution

The present paper describes a HIS prototype that addresses a common practical problem, manifested in the short interaction times between healthcare professionals and patients. The prototype offers a solution that extends the short face-to-face interaction over the full therapeutic process when the patient has left the institution and is lacking structured guidance. The prototype combines standardized predefined communication and personalized ad-hoc communication. The introduction of interaction-templates enables healthcare professionals to offer additional information and support at predefined times of the therapeutic process. The patient is thus guided throughout the therapy and can establish an ad-hoc communication with the healthcare professional whenever needed. Usage of the prototype and the data generated continuously improve the interaction-templates and uncover opportunities to

address patients' problems and likewise potential non-adherence behaviors at the moment when they occur.

With regard to theoretical contributions, the present paper distinguishes between predefined and ad-hoc communication and introduces the notion of interaction-templates. The introduced HIS prototype and the data it generates, enable researchers to further analyze how HIS can establish communication between healthcare professionals and patients beyond their face-to-face encounters, and how efficient HIS need to be designed with regards to structure, form, and content of communication. The prototype also introduces an implementation of refined human support models like "supportive accountability" (Mohr et al., 2011).

Finally, the introduced HIS may present a viable solution to overcome current conceptual and practical limitations by addressing the lack of structured communication between healthcare professionals and patients outside institutions and the resulting loss of guidance and adherence at a critical point in the therapeutic process. This could have a significant impact, both with regard to improved health outcomes and overall healthcare costs.

5 Presentation of the Prototype

A fully functional demonstration of the prototype including the web application on a laptop, the pharmacist application on a tablet-PC, and the patient application on a smartphone will be shown. Screens of these devices can also be mirrored to larger screens to show it to a larger audience. Attendees with an iPhone may download the application from the App Store (iOS) and get a personalized access code for a specific interaction-template.

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Appendix

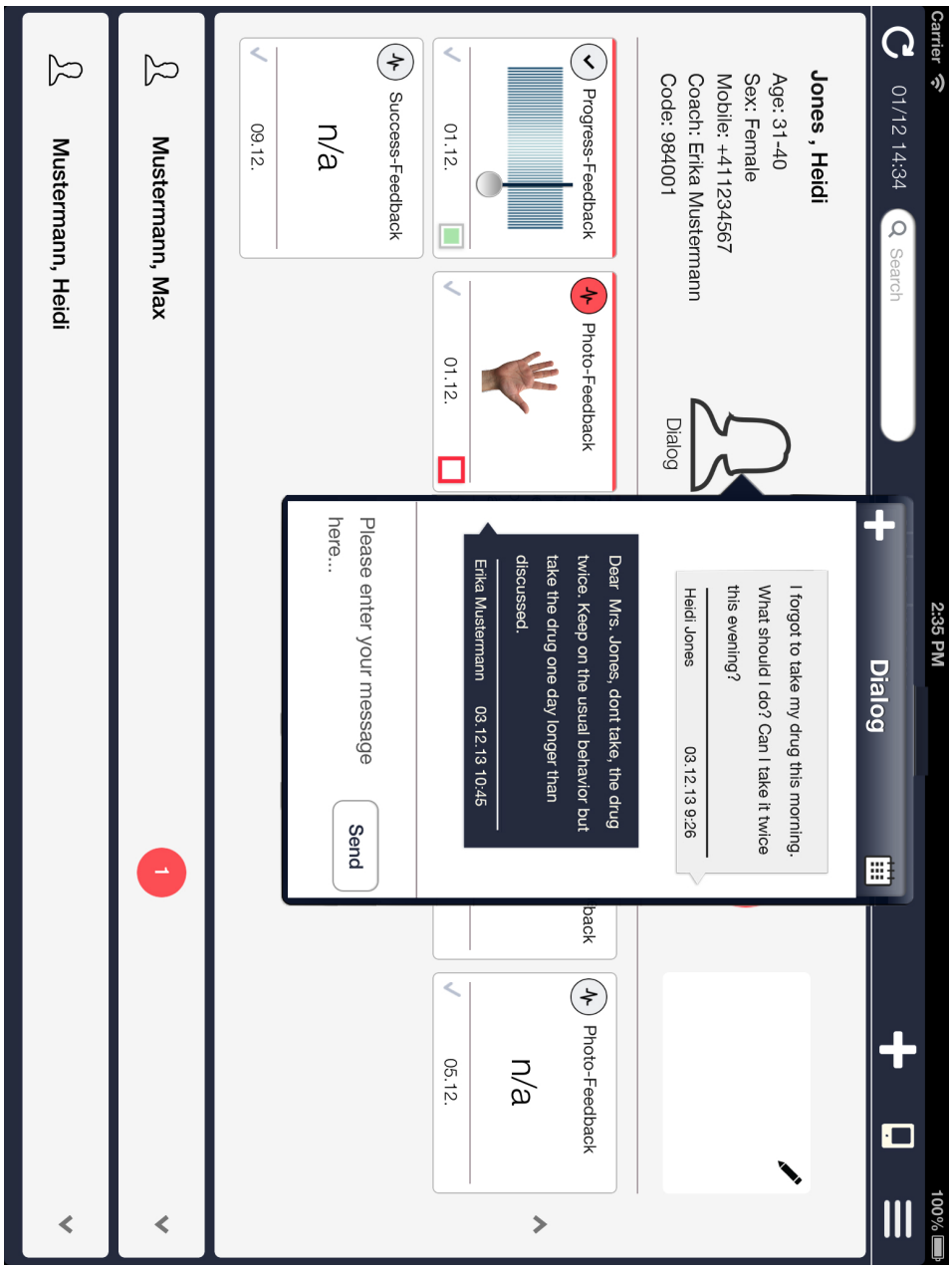

Figure 4. Pharmacist's user interface main screen on a tablet-PC. Combination of predefined communication (interaction-template) and dialog-function for spontaneous ad-hoc communication.

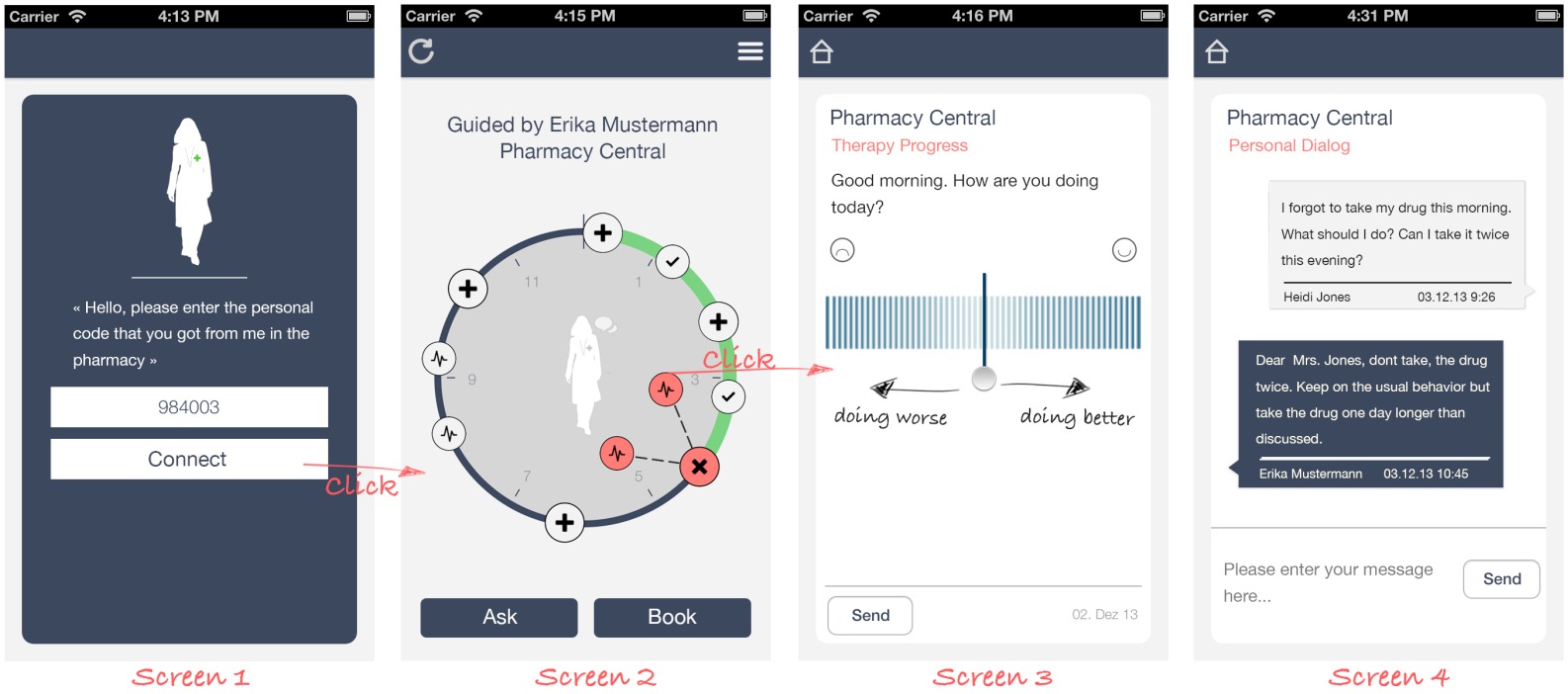

Figure 5. *Patient's user interface main screen on a smartphone. Screen 1 shows the first screen where the patient needs to enter the personalized code from the pharmacist. Screen 2 shows the main screen visualizing the interaction template. The contents of Screen 3 are specific to the type of the communication item. Screen 4 shows the dialog function from the patient's view with the possibility for spontaneous ad-hoc communication.*