A mobile application supporting outpatient treatment and follow-up

Serena BUZZACCHINO\textsuperscript{a}, Giordano LANZOLA\textsuperscript{a,1}, Paolo BOSSI\textsuperscript{b}, Lisa LICITRA\textsuperscript{b} and Silvana QUAGLINI\textsuperscript{a}

\textsuperscript{a}Department of Electrical, Computer and Biomedical Engineering, University of Pavia
\textsuperscript{b}Fondazione IRCCS Istituto Nazionale dei Tumori, Milano

Abstract. An increasing prevalence of chronic diseases is observed, among which cancer is now included because of its survival rates. That trend requires new ways of supporting outpatients and improving their compliance to treatments. This paper introduces HeNeA, a mobile application designed to support patients affected by Head and Neck cancer during their treatments. The application leverages on the mHealth features described in the literature and has been reviewed by a small set of patients during its development. Further evaluation is expected to occur when it will be offered to every eligible patient discharged from the Head and Neck division of a major Italian cancer centre.

Keywords. Telemedicine, Mobile Health, Remote Consultation, Self-Management, Chronic Illness, Head and Neck Neoplasms.

Introduction

According to the Italian National Institute of Statistics, nearly 38% of the population in Italy is affected by at least one chronic disease, while 20% of it is even affected by multiple chronic conditions [1]. An increasing prevalence is also scored by cancer along with a corresponding rise in the survivors number, so that cancer itself is now being considered as a chronic condition [2]. Chronic diseases place a great management burden on outpatients who need to comply with their treatments over an extended time period and pay special attention to symptoms in order to reduce the chances of developing acute episodes and delay the onset of complications. A tight management in outpatients is also crucial during intensive treatments such as those administered for contrasting cancer. In that case, a prompt problem detection and improved communications between patients and doctors help in better tuning the treatment and improving the patient Quality of Life (QoL) and the outcomes [3].

During the past decades people became more technology oriented thanks to a large scale diffusion of digital devices and to the achievements of the Information and Communication Technologies (ICT) that lead to the widespread availability of smartphones and tablets as cheap networked devices able to run custom applications. Their introduction into the healthcare area coined the definition of mHealth as the "delivery of health related services through the use of mobile devices" [4] which is increasingly
seen as a possible way to educate and support outpatients in the management and follow-up of chronic diseases [5] and intensive treatments [6].

This paper illustrates our attempt at exploiting mHealth to support the empowerment and awareness in outpatients while improving their interaction with the specialists responsible for their treatments. We first accomplished a review of the most useful services described in the literature and then developed the Head and Neck App (HeNeA) as a prototype on a smartphone. The app has been designed by tailoring the previously identified services to the specific needs of patients affected by Head and Neck (H&N) cancer during their treatment. It is presently being reviewed by patients enrolled at a major research center located in northern Italy.

1. Methods

Outpatients, together with health care professionals, need to set up useful strategies to take the right decisions in their daily lives, and undertake changes in their behaviors. Those strategies lie along different levels since patients should act at the intrapersonal level for understanding the disease, at the interpersonal level for interacting with their family and caregivers, and at the environmental level for using resources and interfacing with the healthcare community [7]. Moreover, there are different ways of providing information and reporting data that offer different degrees of interpretation for the specific case. mHealth is particularly suitable for outpatients because of its shaping after the paradigm "anytime, anywhere" [8]. Leveraging on that work we performed an analysis of the most useful features for chronic outpatients. Figure 1 illustrates all the different function items we devised, plotted along the above mentioned axes, namely strategy level and degree of interpretation.

The interpersonal strategy level was probably the first one approached by mHealth since it easily capitalized on the remote monitoring facilities started with the advent of the Web [9]. In our diagram we further classified that level along the degree of interpretation axis, proceeding from the Reminders/Schedulers that drive the collection of Patient Reported Outcomes. Those may subsequently trigger the administration of

Figure 1. The mHealth function elements impacting outpatients.
the most appropriate Assessment Questionnaires to the patient. At the intrapersonal level Educational Material includes some reference on the disease, Suggestions provide more focused insights on the patient’s state while Trends give a complete and thorough overview on the case. Finally, at the environmental level the Remote Synchronization is used for exchanging raw data, augmented by the possibility of automatically sending structured e-Mails to the caregivers. At the highest level on the case interpretation axis a Social / Discovery service facility is located, allowing the patient to get in touch with his peers or relevant services [10].

2. Results

The model described in Section 2 has been applied for configuring HeNeA, that is an app for H&N patients undergoing highly distressing therapies with an enormous impact on their QoL. Those patients may benefit from an mHealth intervention improving their education and supporting their interaction with the caregivers [11].

2.1 Architecture

HeNeA may be provided as an institutional service or directly by a specialist. In the first case it connects to a web-service managed by the institution unblocking advanced functionalities, such as the possibility to interface with the Electronic Health Records (EHR) or with a social network. In both cases the app is configured by the physician at the patient’s discharge, in such a way to personalize it for the actual patient.

2.2 Functionalities

HeNeA addresses all the three strategy levels identified (i.e. patient education, self-monitoring, collaboration with the specialist and social interaction with peers) through different views as shown in Figure 2.

![Some views of HeNeA related to the function items supported.](image)

**Figure 2.** Some views of HeNeA related to the function items supported.

An Educational Material section provides information related to H&N diagnosis and treatment, as shown in Figure 2a. That information is stored in a local database and
may be navigated hierarchically starting with main topics such as Diagnosis, Therapies, etc. The same database enables the Tip of the day section proposing a suggestion randomly selected among those applicable to the specific patient. In Figure 2b a map is shown where all the registered users along with additional points of interest (i.e. hospitals with a radiation therapy ward) are displayed. The patient may get in touch with any of those by simply clicking on the icon and sending a message.

The app keeps track of any relevant data concerning the clinical situation. The patient may fill-in questionnaires and record clinical parameters or symptoms. HeNeA is customized by the doctor according to the specific patient case in order to choose the items to be filled-in. While doing so the doctor specifies how often the patient should report that information. This triggers a notification whenever the patient forgets to comply with the request in due time. HeNeA includes the following questionnaires: MDADI (MD Anderson Dysphagia Inventory), assessing the effects of dysphagia in the patient’s QoL; EuroQoL 5D5L and EORTC QLQ C30 (European Organization for Research and Treatment of Cancer Quality of Life Questionnaire) with the H&N35 module; MDASI (MD Anderson Symptom Inventory) assessing the symptoms severity and interference during the patient’s life; BFI (Brief Fatigue Inventory) evaluating the impact of fatigue on the patient’s life. The patient may report also the symptoms related with H&N treatment (e.g. skin problems, swallowing dysfunction, dental problems, pain, fever, nausea, vomiting) and some parameters describing his clinical conditions (e.g. weight, temperature, blood pressure, glycemia). All the data entered are stored locally on the mobile device and are displayed on demand in several charts. Time charts show the time trend of each clinical parameter as in Figure 2c with some data summaries (e.g. mean, standard deviation, range, median, 25th and 75th percentile). The symptoms are plotted in pie charts and bar charts. In Figure 2d two pie charts show the relative frequency of symptoms and the ratio between days free of symptoms and days with at least one. When the doctor customizes the app for a patient, he may optionally add his email in order to receive the patient reports at the chosen frequency (e.g. daily, weekly, monthly). If the app is coupled with a web service, new data acquired will be automatically sent and stored. If the app is used instead directly by a practitioner those data will be sent as an email to him, with two attachments: the same charts available to the patient and an MS-excel file with a report of the questionnaires (including the answers given by the patient and the scores calculated by the app). The patient is always allowed to send additional emails to the doctor including all the reports or just a selected subset of the data (e.g. only the clinical parameters acquired in a given period).

3. Preliminary Evaluation and Discussion

HeNeA has been developed in collaboration with the oncologists of the Istituto Nazionale Tumori (INT) in Milan to help H&N cancer patients in better managing their health during treatment and follow-up. It focuses on the interaction needs between patients and oncologists since the Italian healthcare system sees specialists as the main case managers. However the app is suitable for including other roles, such as the General Practitioners, albeit this would require a change in the underlying workflow.

During the design of HeNeA, as a preliminary validation, we asked five patients to comment on the app after explaining all its functionalities. We also asked two medical doctors not involved in the app development to provide their comments. A set of suggestions has been collected and is being used for improving the app. Patient
concerns were mainly about personalization and daily needs. For example, they asked for (i) suggestions on how to vary their diet while remaining compliant with dietary constraints, (ii) how to prepare themselves for invasive tests or interventions, and (iii) how to easily communicate with doctors. Another type of request is to augment the app with some sensors to perform simple measurements at home, such as monitoring audiometric capabilities.

Some patients and doctors were critical about the social facility of the app, but interestingly, for very different reasons. Some patients were concerned about their privacy while others simply did not feel the need of sharing their experience; doctors instead were worried about the possibility that some patients, comparing their treatment with their peers’ ones, could complain about the treatment actually received. Further evaluation about HeNeA is needed and will be accomplished once the app will be routinely offered to every eligible patient treated within the H&N division of INT. In order to assess the impact of HeNeA on the patient daily life and QoL, we are planning to evaluate patients and doctors levels of satisfaction through specific questionnaires, possibly exploiting tools for their remote administration [12]. Moreover, since any technological innovation may have an impact on the clinical workflow [13], we will try to identify possible changes to the actual workflow followed for treating H&N patients. Those include the need of allocating further resources or re-allocating existing ones, scheduling and organizing control visits, and improving communications between patients and caregivers.

References