

The FTGM App: a digital health system to improve well-being of inpatients with heart or lung disease

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Abstract

Background: An app providing material for education and entertaining is a possible way to support patients and healthcare providers in achieving person-centered care.

Methods: An app tailored on the Fondazione Toscana Gabriele Monasterio (FTGM), a research hospital treating cardiac and lung disorders, was created. A pilot evaluation project was conducted on consecutive patients hospitalized for heart or lung disorders. Patients were asked to complete an assessment questionnaire.

Results: The FTGM App provides information on diagnostic and therapeutic investigations, hospital and healthcare personnel, and includes content for entertainment and learning. It was tested on 215 consecutive patients (75% men, 66% aged more than 60 years, and 40% with a primary or middle school degree). Sixty-nine percent of patients used the FTGM App, including 67% of patients aged >80 years and 65% of those with an elementary education (65%). Patients gave positive feedback on the app layout. Many (76%) looked for information on doctors and nurses in the “People” section. Sixty-five percent of responders had used at least one of the sections called “Music” and “Museum visits”. The app had helped many patients perceive the hospital as a more liveable place (68%), feel less anxious (76%), and more engaged in the diagnostic and therapeutic workup (65%). Overall, the majority of responders (87%) rated the app as “excellent” or “good”, and almost all (95%) would have recommended other patients to use the app.

Conclusions: The FTGM App is a possible tool to improve patient well-being during hospitalization.

Abstract: 244 (text)

Keywords: app; hospital; well-being; quality of life; patient.

Background

During hospitalization, patients experience an interruption of their daily routine and a sort of suspension of the normal flow of time, as well as a removal from their usual environment and a limitation of their personal space and intimacy [1]. Hospitalization represents a stressful experience, especially in case of recurrent admissions, isolation or admission in intensive care units [2]. It is then essential to provide the patient with supporting tools that can improve the quality of the hospitalization, thus following a medical approach that is centered on the person and not only on the disease [3]. Indeed, an exaggerated attention to the measurable parameters of the patient's body, the disease categorization and the relative effects of therapies has been recognized to "de-humanize" care across the last century, though being also very clinically effective [4]. In recent times, the notion of "person-centered medicine" is becoming crucial in the management of chronic disorders, which require the active involvement of patient and their caregivers in the processes of diagnosis and management [5].

A useful instrument to pursue a person-centered strategy is digital health, defined as the use of technology, artificial intelligence and communication tools to improve patient health [6]. Some applications of digital health are represented by wearable devices and telemedicine strategies for remote monitoring [7,8]. Several other approaches have been investigated, from messaging services that increase the adherence to treatment to applications that improve disease prevention or management [9-13]. In general, most healthcare related apps focus on providing functionalities like clinical reference, condition monitoring, seek of medical assistance, hospital way-finder, treatment adherence and healthy living [14,15]. Strategies to help organizations to find or develop effective apps have been also explored in recent years [16,17]. In general, a broader attention to the patient's wellbeing as a person seems to need further investigation.

So far, most projects have been evaluated in small and/or mono-center studies. Moreover, the analyzed applications often had specific purposes intrinsically related to the pilot hospital or to a

particular aspect of a certain disease. Evidence about applications providing a broader support of the patient with heart or lung disease is limited. Based on this heterogeneity, the implementation of digital health strategies into large-scale and everyday practice is still a source of concern [18,19].

The Fondazione Toscana Gabriele Monasterio (FTGM; Pisa, Italy), a hospital devoted to the care of heart and lung disorders, and the Institute of Mechanical Intelligence (IIM) of the Scuola Superiore Sant'Anna of Pisa, working in robotics and biomedical research, developed a mobile application that provides the patient with information on their disease, their expected care journey, as well as information on the institution and the medical staff [20,21]. Recreational material is also provided. A pilot study was conducted to evaluate the simplicity of use and patient satisfaction (**Graphical Abstract**).

Methods

The setting

The FTGM is a research hospital with two sites located in Pisa and Massa (Tuscany, Italy). The Pisa site has 52 beds (43 for patients with cardiac disorders and 9 for patients with lung disorders), including a 6-bed intensive care unit. Patients are referred from the outpatient clinics or from the Emergency Department of the University Hospital of Pisa.

App development

The FTGM App was developed by a computer engineer (I.T.), targeting mobile tablet devices. The contents were created by a panel of cardiologists, pulmonologists and nurses working at the FTGM, coordinated by R.P., E.B. and M.F.S. A psychologist (A.L.D.) supported the activity. The design phase was supervised by C.E. and M.B. of the IIM.

The majority of patients admitted to the FTGM (58%) are aged more than 65 years, which requires an attention to accessibility according to Material Design Guidelines [22]. Several “sections” were

accessible from the main menu (**Figure 1**). Sections contain “topics”, the actual informative sheets, presentations or activities that users could explore (for example, heart failure and arrhythmias are presented in the section about heart disease).

Pilot validation study

The app was evaluated on 215 consecutive patients hospitalized for heart or lung disorders, excluding repeated hospitalizations. Each patient was provided with a tablet with the app installed. At the time of admission or when clinical stability was achieved, nurses mentioned the existence of the app without providing any specific instructions for use. The Institutional Review Board waived the need for an informed consent for this study.

At discharge, patients were invited to complete a multiple-choice questionnaire including 40 questions that collected information on disease perception and awareness, feelings during the hospital stay, use of the app, assessment of its layout, use of specific sections, general assessment and impact of the app. The questions and possible answers were defined by a multidisciplinary team including cardiologists (R.P., M.E.), pulmonologists (E.A., S.M.), a psychologist (A.L.D.), a computer engineer (I.T.) and computer scientist (C.E.), following the guidelines of Patient Reported Experience Measures questionnaires [24] and with the support of a Health Management specialist (S.D.R.). The questions and answer options are reported in the **Supplemental material**. The questionnaire was created using Google Forms and administered through a tablet. Nurses encouraged patients to complete the questionnaire before discharge, regardless of whether they had used the app or not.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics (version 24). Categorical variables were expressed as number and percentage. Comparisons were performed through the Chi-square test. p values <0.05 were deemed significant.

Results

App features

The homepage contains 8 icons: “Il mio cuore” (“My heart”), “Il mio respiro” (“My breath”), “Il mio percorso” (“My cure pathway”), “I miei esami” (“My exams”), “Musica” (Music), “Visita al museo” (“Museum visits”), “Il mio diario” (“My diary”), “Persone” (“People”), and “Il mio ospedale” (“My hospital”) (**Figure 1**). The first 4 sections present a list of topics, each organized in a page with an overview video prepared by the professional in charge, and some descriptive yet educational text. The “My heart” section provides a simple presentation of the main cardiac disorders (coronary artery disease, heart failure, and arrhythmias): a video provides an overview of each disorder, which is described more extensively in an accompanying text. The “My breath” section presents two lung disorders: chronic obstructive pulmonary disease and pulmonary hypertension. The “My cure pathway” section offers practical information on admission procedures, the possible exams performed during hospitalization, the discharge and follow-up planning. The most common exams are presented more extensively in a dedicated section (“My exams”). The “My hospital” section contains a virtual map of the FTGM. The “Music” section provides an essential playlist of classical and modern music available with a free license [23]. The “Museum visits” section enables virtual tours of some museums in Italy (i.e., the Uffizi Gallery, Vatican and Capitoline Museums, and Pinacoteca di Brera) through direct connection to the official webpages. “My diary” allows the patient to keep notes during the hospitalization, writing down thoughts and considerations. Each note can be saved as public or private in the app, meaning that public ones can be anonymously read by the healthcare staff in FTGM and other patients. This requires the user to complete a registration and to keep data safe. “People” section consists in an album of photos and personal introduction by every healthcare professional in FTGM.

Validation study

General information

The applicability of the app in everyday clinical practice was tested on 215 consecutive patients (75% men, 66% aged more than 60 years, and 40% with a primary or middle school degree) (**Table 1**). The vast majority of patients (88%) was hospitalized for cardiac disorders, in agreement with the proportion of beds in the Cardiology and Pulmonology wards.

Disease perception and awareness, patient feelings

Nineteen percent of patients rated their health status during the hospitalization as fair to very poor. Furthermore, 18% of respondents felt unable or not very able to detect changes in his/her health status, and 66% to adapt the therapeutic strategy to changes in his/her health status. As many as 11% of patients felt unable or not very able to take his/her medications as prescribed. During the hospital stay, 12% had felt sad (either “always” or “often”), 19% had felt nervous, and 9% powerless (**Table 2**).

Use of the FTGM App

Patients using the FTGM App were 148 (69%). Among the patients not using the app and who provided an explanation (n=67), most stated they had not understood that they could use the tablet or had waited for further instructions (54%), while others were reluctant to use electronic devices (23%), had their own devices (14%), or had physical limitations (6%). Male patients were less likely to use the app, while no significant differences across age categories, study titles, or Cardiology vs. Pulmonology ward emerged. Furthermore, patients who used the app were less confident about their disease status than patients not using the App (**Table 2**). Interestingly, 10 out of 15 patients aged >80 years (67%) and 13 out of 20 of those with an elementary education (65%) used the App (**Table 1**). Patients who used the app felt less able to take medications as prescribed, to assess the presence and severity of symptoms or changes in the health status, or the efficacy of therapies (**Table 2**).

Among app users, 83% consulted at least one of the sections called “My Heart”, “My Breath”, “My pathway”, or “My tests”; 29% (and 35% of responders) had searched for answers on the App when they had a doubt about his/her condition or exams, and 89% had found clear answers. Nonetheless, 74% (or 87% of responders) still preferred to interact with doctors and nurses than using the App, and 77% (or 84% of responders) stated that he/she had received the most important information from doctors (**Table 3**).

Assessment of the App layout

All patients but one rated the App as easy to use, 83% the texts as easy to read, and 80% the images as useful for readers (**Table 4**).

Use of specific sections

Many patients (76%) looked for information on doctors and nurses in the “People” section. Sixty-five percent of responders had used at least one of the sections called “Music” and “Museum visits”, and 8% had used both. The recreational material was usually deemed interesting and useful for relaxation, with 84% answering “Yes, definitely” or “Yes, fairly enough” to the corresponding questions.

General assessment and impact of the App

The App had helped many patients perceive the hospital as a more liveable place (68%), feel less anxious (76%), and more engaged in the diagnostic and therapeutic workup (65%). Overall, the majority of responders (87%) rated the App as “excellent” or “good”, and almost all (95%) would have recommended other patients to use the App (**Figure 2**).

Discussion

We present an app providing information on diagnostic and therapeutic exams, hospital and healthcare personnel, and contents for entertainment and cultural study to patients admitted for heart or lung disorders. We also report the results of a pilot validation study conducted at the same Institution. The main findings are that patients often used the app even without specific instructions, and overall seemed to appreciate this tool.

The implementation of new digital health approaches to care practice, prompted by both technological advancements and the recent pandemics, has led to the creation of tools capable of transforming hospitalization from an alienating into a positive experience [25]. Various types of digital technologies have improved the quality, efficiency, and accessibility of medical care, as demonstrated by the telemedicine applications that reduced hospitalizations and mortality rates among subjects with cardiovascular diseases [26,27]. Digital health approaches have been tested and validated in several settings [28]. However, the main mobile applications were designed to detect daily healthy behaviors and increase disease education through services improving therapeutic adherence, prevention, and health promotion [18,19].

We are aware of only two applications sharing some similarities with the FTGM App. The app "Colorectal Digital Checklist" helps patients to face the surgery of colon-rectal in the best physical condition and supports them before admission and after discharge, with the aim of accelerating post-surgery recovery and reducing complications. Once the doctor has confirmed the optimal post-operative state, the patient leaves the application and all the data is transferred to the electronic health records [29]. The "Visio Medic" app, developed by the University of Brescia, supports the patient with pancreatic cancer throughout the treatment process, clarifying doubts and fears, offering practical advice and easy to understand explanations. There is also an avatar guiding the patient to the app's operation and contents [30].

The purpose of the FTGM App was to improve the experience of the hospital stay by increasing the level of patient awareness of his/her disease status and the care pathway. The availability of recreational material is an additional element that may promote patient's well-being.

Importantly, patients were not specifically instructed on how to use the tablet, but more than two thirds of participants managed to employ it. Among the minority of non-utilizers, more than one half had not understood the availability of the app or waited for additional instructions, while the remaining subjects were diffident or not able to use. Interestingly, the app was often used even by elderly individuals or patients with low-grade education, and was generally considered as clear and easy to use. Among users, the application showed a high percentage of satisfaction regarding the use of contents that explained the disease and pathway care. However, patients still preferred to interact with medical staff about their clinical status and crucial information. The possibility to better identify the faces and descriptions of healthcare providers on the app was greatly embraced, as demonstrated by the three quarters of subjects who explored the "People" section. Similarly, the recreational material was largely adopted and patients generally enjoyed the access to music or virtual tours. In this pilot evaluation project, the app was judged as "good" or "very good" by virtually all patients, with markedly positive opinions regarding all the areas explored, first of all the reduction of anxiety related to the disease and diagnostic or therapeutic procedures. Furthermore, the app provides information on cardiac and lung disorders, diagnostic-interventional procedures and preparation for instrumental tests, allowing a "personalized" use of the various sections. The patient may feel more involved in the diagnosis and treatment process, with the effect of favoring the therapeutic alliance, education and lifestyle (including preventive behaviors), adherence to therapies and, last but not least, disease management. A strength of the study is the design and layout of the FTGM App itself, which resulted to be user-friendly, generally considered easy to use, even for elderly patients or patients with low-grade education, without specific instructions.

Short-term developments include the creation of additional content related to heart disease (such as hypertrophic cardiomyopathy, dilated cardiomyopathy, arrhythmogenic cardiomyopathy, cardiac

amyloidosis, heart rhythm disorders) and lung disorders (respiratory insufficiency, bronchial asthma, pulmonary emphysema, and chronic bronchitis, obstructive sleep apnea syndrome). The medical and nursing staff is also working on the creation of information regarding further instrumental tests. Other possible developments include the possibility to choose meals and call for assistance of the nursing staff directly on the tablet. The app may be further improved by adding to the recreational area some games to keep the mind active during the length of stay in hospital. Furthermore, the section on lung diseases may be enriched with information on pulmonary fibrosis because, being a disease with no real curative option, patients often feel scared or powerless, and they may benefit from support or a deeper knowledge. Among the medium-long term developments, we can identify the realization of a study on a larger number of patients and, based on user feedback resulting from the satisfaction questionnaires, the app will be optimized in all its components. The inclusion of content relating to Heart Surgery and Pediatric Cardiology is planned and may trigger the implementation of the app in more extended clinical scenarios.

Several limitations should be acknowledged to the development and validation of the FTGM App. First, this should be a tool to support person-centred care, but no patients were involved in the developmental phase and no co-design methodology was applied. Second, the validation cohort was rather small, and patients with heart or lung disorders could not be evaluated separately. Third, information on elective vs. urgent admissions or specific causes of admissions was not collected, although it could affect patient eagerness to use the app. Another possible limitation is the lack of data about the length of admission, that could also help to understand which patients would benefit more from the use of the FTGM App. Finally, study results are entirely based on patient answers, and response bias (e.g., social desirability bias inducing patients to give positive answers) may be an issue.

In conclusion, the FTGM App provides information on diagnostic and therapeutic exams, hospital and healthcare personnel, and contents for entertainment and cultural study. Participants showed a great appreciation of this attempt to deliver person-centered care.

Figure legends

Graphical Abstract. Main results from the pilot study of the FTGM App in patients hospitalized for heart or lung disease.

Figure 1. Homepage of the FTGM App.

See text for further details and the English translation of the titles.

Figure 2. Global assessment of the FTGM App.

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