Collaborative Design and Development of a Patient-Centered Digital Health App for Supportive Cancer Care: A Participatory Study

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Submitted to: Journal of Medical Internet Research
on: March 14, 2025

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Abstract

Background: Digital health tools such as smartphone apps, have the potential to improve supportive cancer care. Although numerous smartphone apps for supportive care are available, few are designed with a user-centric approach. Such an approach is crucial for successful implementation, as it may improve user engagement, usability, and adoption in clinical settings.

Objective: This study aimed to co-design and develop a digital health app in collaboration with cancer patients and healthcare professionals while exploring factors influencing future acceptance.

Methods: A participatory study was conducted with the major stakeholders at University Hospital Zurich (USZ). Workshops, individual qualitative interviews, and focus groups were held with healthcare professionals, cancer survivors and cancer patients. The co-design process was divided into three phases: pre-design, generative phase, and prototyping. User-centered design methods included scoring cards, and think-aloud protocols to co-create design ideas, identify important functionalities, and test usability. Qualitative data were analyzed using thematic analysis.

Results: Patients and healthcare professionals emphasized the need for a digital health app to improve patient-healthcare professional communication, digitalize supportive care screening and processes, and enhance self-efficacy. The resulting app, OncoSupport+, was co-designed and integrated into the clinical workflow for supportive cancer care. It consists of (1) a patient dashboard to record Patient Reported Outcomes Measures (PROMs), as well as to give access to personalized supportive care information and contact details; and (2) a nurse dashboard to visualize patient data, which can be used during nursing consultations. Potential facilitators for adoption included ease of use, workflow integration, introduction by healthcare professionals and technical support, while internet anxiety may be a potential barrier.

Conclusions: Collaborative development with patients and healthcare professionals is crucial for creating digital health tools that can be implemented successfully. Future research should evaluate the feasibility of long-term implementation, the real-world usability, and effectiveness of OncoSupport+ on communication, self-efficacy, and quality of life.

(JMIR Preprints 14/03/2025:73829)
DOI: https://doi.org/10.2196/preprints.73829

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Keywords: Digital Health; mHealth; Supportive Care; Cancer; Patient Reported Outcome Measures

Introduction

Cancer is a highly prevalent condition with increasing incidence rates, and the leading cause of death worldwide[1]. As improvements in diagnosis, treatment, and surveillance have led to better survival rates, patients with cancer are living longer[2], though a considerable portion of patients experience significant morbidity and symptoms related to both the cancer and its treatment. Patients with cancer often exhibit physical, emotional, social, spiritual, and informational needs, and the aggregated impact may ultimately contribute to exacerbated health outcomes and diminished quality of life[3]. Supportive care—focused on the prevention and management of cancer symptoms and cancer treatment-related symptoms—has been widely acknowledged as an essential component of comprehensive cancer care[4].

Several cancer centers have established specialized supportive care services, employing the expertise of a multidisciplinary team with diverse medical specializations such as nutritionists, physiotherapists, and psychologists. Supportive care has been shown to improve quality of life[5], tolerability of cancer treatments, improved survival, and systemic health economic benefits[6]. However, studies continue to report unmet supportive care needs, indicating that significant efforts are still required to ensure the effective implementation of evidence-based supportive care in clinical practice[7]. Specifically, the Multinational Association of Supportive Care in Cancer (MASCC) has emphasized the routine collection of Patient-Reported Outcome Measures (PROMs) to facilitate timely, individualized supportive care and empower patients through evidence-based education[7]. In this context, digital health tools, particularly mobile health (mHealth) applications, have emerged as promising solutions for delivering patient-centered supportive care interventions[8].

A growing number of digital health applications offer mental health support, symptom self-management, and educational resources, with digital symptom monitoring and PROMs assessment being among the most commonly integrated interventions for supportive cancer care [9]. Although systematic reviews and meta-analyses [10,11] have shown that digital health interventions may improve symptoms and quality of life, their implementation and adoption remain limited, particularly in cancer care [12]. A key reason is the limited involvement of key stakeholders including patients and healthcare professionals during development leading to suboptimal adoption and effectiveness [8,11,13]. Co-design has been identified as a promising approach to ensure that digital health interventions are patient-centered, clinically relevant, and technically feasible[14].

By incorporating participatory and iterative stakeholder engagement, co-design can help tailor digital health interventions to meet the needs and preferences of both patients and healthcare providers while facilitating the early identification of implementation barriers and factors influencing adoption and long-term engagement. However, despite its potential, co-design is not always rigorously applied in digital health research, as studies often lack structured methodologies, fail to systematically integrate diverse stakeholder input, and do not adequately assess long-term feasibility[15]. Addressing these gaps is crucial for developing user-centered, and sustainable digital health interventions in supportive cancer care.

The overall aim of this study was to collaboratively design and develop a digital health app for supportive cancer care together with the relevant stakeholders (cancer patients, cancer survivors, and healthcare professionals). Specifically, the first objective was to map the context of supportive cancer care at the University Hospital Zurich including challenges and needs. The second objective was to identify specific functionalities and features of the app and gather the patients and nursing perspectives; as part of this objective we also explored factors that can potentially influence the uptake and implementation of the digital health app for supportive cancer care. Finally, the third objective was to design and develop the prototype and user interface of the digital health app to be technically implemented.

Methods

Study Design

This participatory study was conducted between May 2023 and October 2024, as part of the Digital Health Zurich initiative[16] – a collaboration between the University of Zurich, the University Hospital of Zurich and the Zurich University of Applied Sciences (ZHAW). The overarching goal of Digital Health Zurich is to create a sustainable, data-driven, and cross-institutional digital ecosystem by fostering collaboration between patients, healthcare professionals, technology developers, and researchers in Zurich and beyond. The initiative aims to translate research into real-world digital health solutions, with a strong focus on patient and provider needs, participatory development, cross-institutional cooperation, and innovation within the healthcare system. As a use case, this study was conducted at the University Hospital Zurich, in collaboration with the Department of Oncology and Hematology and the Comprehensive Cancer Center Zurich. The respective ethics committee determined that this study did not fall under the Human Research Act (Req-2023-01095).

The stakeholders included in the study were cancer patients and patient advocates, cancer nurses, supportive care specialists, oncologists and the research team; more details are listed in the following sections (i.e., Recruitment and Stakeholders). Figure 1 shows an overview of the study design, employing iterative stakeholder engagement, user-centric approaches, and design thinking techniques. The study can be divided into different phases, similar to the framework suggested by Noorbergen et al. 2021[14] for co-designing mobile health systems, which is a novel extension of the work by Sanders and Stappers[17]:

1. **Pre-design phase**: This phase aims to understand the context of supportive cancer care at the University Hospital of Zurich, including the challenges faced by cancer nurses and patients in accessing supportive cancer care.
2. **Generative phase**: This phase focuses on brainstorming digital health app functionalities, as well as identifying potential factors that may impact future uptake of the technology.
3. **Prototyping phase**: Taking into account the findings from the previous phases, this phase aims to iteratively develop a prototype of the digital health app by gathering feedback from the intended users.

As people often think about challenges and potential solutions, the pre-design phase and the generative phase were not always completely separated. Between June 2023 and October 2024, the research team held collaborative workshops, focus groups with cancer nurses, and qualitative interviews with patients and patient advocates.

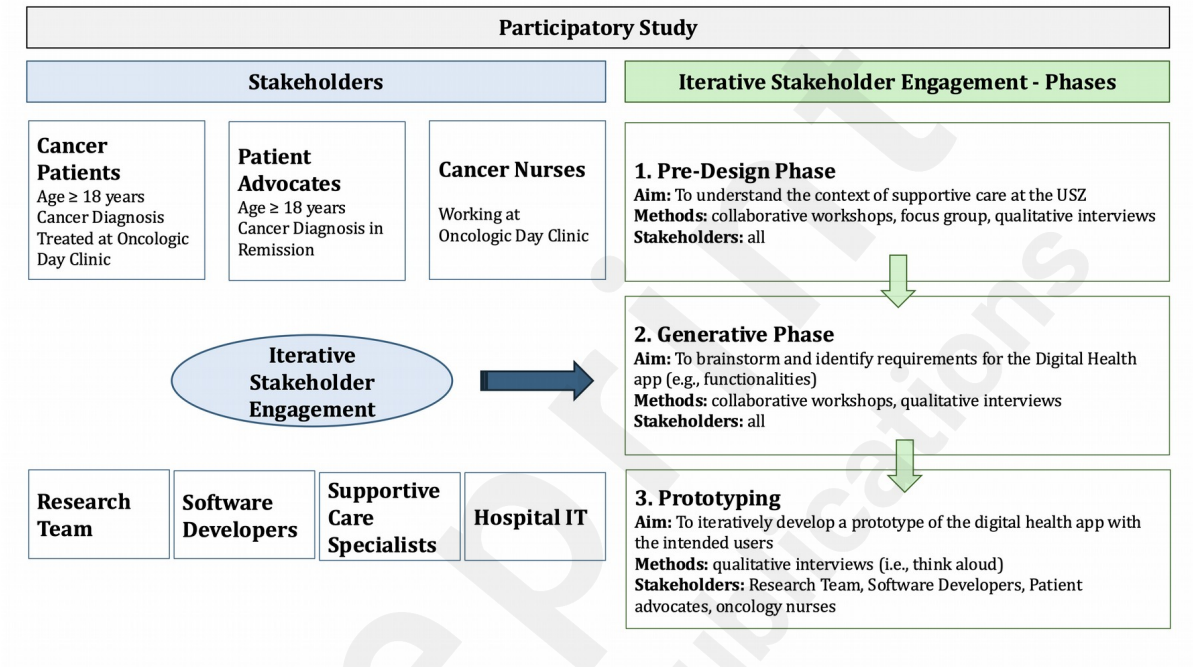

Figure 1: Participatory Study Design employing Iterative Stakeholder Engagement and divided in three phases (i.e., pre-design, generative and prototyping)

Recruitment and Stakeholders

Cancer Patients and Patient Advocates

Cancer patients were recruited for the study if they were being treated for cancer at the oncologic day clinic of the Department of Oncology and Hematology at the University Hospital Zurich and were 18 years or older. Recruitment was conducted by cancer nurses. Potential participants were introduced to the research project through an informational flyer outlining the study procedures and offering the option to participate in interviews while receiving chemotherapy or immunotherapy in the oncologic day clinic. Interested patients could provide their contact details to arrange a preferred date and time for an interview with a researcher, either via email or phone. Out of the eight patients that left their contact details, six agreed to participate in the study.

As cancer patients often experience fatigue and may face challenges in participating in research

activities, four patient advocates from the Swiss Group for Clinical Cancer Research (SAKK) were also recruited. These advocates are cancer survivors in remission, enabling them to offer insights from both patient and survivor perspectives. Their ability to engage more actively made them valuable contributors to the research.

Although the study initially aimed to enroll approximately thirty patients for qualitative interviews and/or focus groups, the principle of data saturation was followed. Recruitment was stopped once no new themes were identified, ensuring that the data collection was thorough and meaningful without overburdening participants.

Written informed consent was obtained from each patient and patient advocate. The age of participants ranged from 29 to 75 years, with a mean age of 50.3 years, which is lower than the average age typically reported for the cancer population[18]. Among the participants, four out of ten were female. Most participants held advanced degrees, with six out of ten having completed a bachelor's degree or higher (i.e., tertiary education). None of the participants were employed full-time at the time of the study; four worked part-time, and two were retired.

All participants owned both a smartphone and a computer. While all participants used their smartphones daily, seven out of ten reported additional daily use of their computers. Furthermore, six participants owned a tablet. Half of the participants rarely needed assistance when using their devices, while four required assistance sometimes, and one needed assistance daily. Further details about the characteristics of participants can be found in Multimedia Appendix 1, Table S 1.

Cancer Nurses

Inclusion criteria for the cancer nurse was that they work at Department of Oncology and Hematology of the University Hospital Zurich. Nurses were recruited by a member of the project team who also works as a cancer nurse at the oncologic day clinic. Written informed consent was obtained from each nurse. All nurses who participated in the study were female. They were between 37 and 53 years old and had at least ten years of experience as cancer nurses.

Supportive Care Specialists

Supportive care professionals, including a supportive care nurse, a nutritionist, two

physiotherapists, and medical doctors with specializations in oncology, palliative care and complementary medicine, were engaged in the participatory study to share their expertise and ensure that the app aligned with clinical practices in supportive cancer care.

Research Team

The research team consisted of one cancer nurse and one oncology doctor, researchers in digital health, computer science, computational health, and medical informatics, as well as a UX designer. Two of the computer science researchers also contributed as software developers for the digital health app. Digital health researchers were responsible for organizing, moderating and conducting the research activities. One of the computer science researchers supported data collection.

Iterative Stakeholder Engagement: Study Procedure

Between June 2023 and October 2024, data were collected during collaborative workshops, focus groups with cancer nurses, and qualitative interviews with patients and patient advocates. All interviews and focus groups were conducted in either (Swiss) German, English, or Italian, while the collaborative workshops were held in English (the language used by the project team). Focus groups and qualitative interviews were recorded, while during workshops, two researchers took notes, cross-checked them, and shared the notes with other team members.

During the pre-design and generative phase, one collaborative workshop within the research team, one workshop with supportive care specialists, one focus group with cancer nurses, and qualitative interviews with cancer patients and advocates were carried out. An initial workshop was held in June 2023 with the research team to map and understand the context of cancer supportive care at the hospital and define a problem statement for this study. Between February and June 2024, qualitative research with cancer nurses, cancer patients, and advocates was conducted to identify and discuss challenges and needs related to supportive care at both the individual and hospital levels, as well as their experiences with digital health and the functionalities proposed by the research team. Specifically, a focus group (1.5 hours) with cancer nurses was held. In parallel, four patient advocates and six cancer patients participated in one-hour, semi-structured qualitative interviews with a researcher. During the interviews, when discussing the functionalities of the app, a scoring card was given to patients to rate the usefulness of each functionality on a scale of 1 to 10, with 10 being a "must-have" functionality. Additionally, a two-hour workshop with supportive care professionals and digital health

researchers was conducted to design a rule-based algorithm and map the experts logic for the digital health app.

Finally, from July to October 2024, the prototyping phase was conducted. Based on insights from the previous phases, a digital health researcher iteratively developed user requirements and specifications documented in Confluence[18], which were then translated into user interface designs with Figma[19] by the UX designer. A user flow was created to outline app navigation, and this flow was tested by a cancer nurse and four patient advocates. The prototype of the user interface was subsequently developed and iteratively reviewed by the same group using the think-aloud methodology. Finally, a workshop involving healthcare professionals and the research team was held to evaluate and further refine the prototype.

A meeting between the software developers and the IT department of the hospital was also held to assess different digital solutions and explore how these could potentially be integrated into the IT system of the hospital.

Data Analysis

The qualitative data from interviews and focus groups were transcribed, translated, and analyzed using thematic analysis, following Braun and Clarke et al., 2006[20] methodology.

All audio recordings were transcribed orthographically using OpenAI Whisper[21], performed locally to ensure data security. Transcripts were translated to English, initially using Whisper and then manually checked and corrected by bilingual researchers who conducted the interviews, ensuring high-quality transcription and translation. The corrected transcripts were used for analysis. Thematic analysis was conducted following the six-step process of Braun and Clarke[17]: (1) familiarization with the data, (2) generating codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, (6) producing a report. To reduce bias, analyses were conducted by the first two co-authors of this paper. Results were summarized with mind maps, journey maps, frequencies of reported themes by using Microsoft PowerPoint[22] and R Studio[22]. Median and ranges were reported to summarize scorecards on functionalities. Finally, factors impacting on the uptake of digital health apps were described using the “Unified theory of acceptance and uptake of technologies” framework validated for digital health interventions[23]. More details about data analysis can be found in the Multimedia Appendix 1 ‘Thematic Analysis’.

Results

Pre-Design Phase

Cancer Supportive Care at the University Hospital of Zurich

Cancer patients can access different supportive care services at the hospital through different pathways (cancer nurse consultation, physician consultation or direct contact).

To improve the access a specialized nurse identifies patients receiving treatment for the first time at the Department of Oncology and Hematology and asks whether they would like to have a cancer nurse consultation. During this consultation, the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30)[24] and the Distress Thermometer[25] are used to assess supportive care needs and distress via a paper-based questionnaire. Additionally, a supportive care brochure is handed out to patients during the consultation. The nurse can provide recommendations on one or more services. The University Hospital of Zurich offers twelve supportive care services: psycho-oncology, geriatric medicine, living will and advance care planning, palliative care, genetic counseling, exercise/sport programs, nutrition counseling, smoking cessation advice, social services, pastoral care, 'Look Good Feel Better' workshops for cancer patients, nurse counseling, and complementary medicine. Patients can register themselves for some of the services, while others may require a referral from a doctor or a specialized nurse.

Challenges in Cancer Supportive Care and Opportunities for Digital Health

Challenges and opportunities for digital health emerged from qualitative interviews and focus groups with cancer patients and nurses, are summarized in Table 1 (Extracts from interviews and focus groups with corresponding themes are available in Multimedia Appendix 1).

Table 1: Challenges in Supportive Care and Opportunities for Digital Health at the Zurich University Hospital (Pre-design Phase)

Theme 1: The Need for Digitalization and Standardization of Supportive Care
● **Digitalization and Standardization of Screening:** Transition from paper-based PROMs questionnaires to digital platforms to enhance screening rate and identification of unmet supportive care needs. ● **Individualized Supportive Care Timing**: Develop digital health systems that adapt to individual patient needs for accessing supportive care at adequate times.
Theme 2: Challenges in Patient-Healthcare Professional Communication
● **Difficulty in Reaching Doctors**: While patients report a good relationship with their oncology doctors, they often face challenges in reaching them due to busy schedules. Patients appreciate knowing they can rely on nurses for support. ● **Treatment-Related Fatigue**: Fatigue from treatment can hinder effective communication

during consultations. Pre-consultation digital screening could help patients conserve energy and maximize consultation time. ● **Language Barriers**: Some patients do not speak the local language (e.g., German). Future app iterations may accommodate multiple languages to improve communication and self-efficacy.
Theme 3: Improving Self-efficacy and Managing Information Overload for Cancer Patients
● **Information Overload:** Patients receive a large amount of information in form of brochures, documents and during consultations with medical doctors and nurses. ● **Information Digitalization**: Simplify the delivery of information by providing it in digital form, making it accessible when it is needed. ● **Personalized and Trustworthy Information:** Ensure that digital content is tailored, reliable, and easy to understand, addressing the individual needs of each patient.
Theme 4: Need for Connection, Medical and Social Support for Cancer Patients
● **Peer Support:** Patients express a desire to connect with others who are in similar situations. ● **In-person Consultations with Healthcare Professionals:** Despite digital advancements, patients value and require face-to-face interactions with healthcare professionals.

Nurses emphasized the need for digitalization and standardization of screening procedures, while patients highlighted the importance of accessing supportive care services when most needed (**Table 1**, **Theme 1: The Need for Digitalization and Standardization of Supportive Care**). For instance, some patients prefer receiving information and accessing supportive care early in their treatment, whereas others find it more beneficial later.

- *For example, a nurse stated: "At the moment, we give patients a paper-and-pencil version of the screening when they come to the hospital. […] So, the digital screening should actually improve this by allowing patients to answer in advance […]. It should also improve the screening rate and relieve nurses from having to conduct the screening themselves. This way, patients can complete it at home, and we can spend more time discussing their responses during the consultation."*
- *One patient shared: "I think in the beginning it's helpful to have, you know, the links to supportive care services.", while another shared: "And first, I didn't think about nutrition counseling or exercise. . . the medical treatment was in the focus. But later I realized I had to check my weight more carefully and try to do sports again."*

Both healthcare professionals and patients highlighted the importance of improving patient-healthcare

professional communication (**Table 1**, **Theme 2: Challenges in Patient-Healthcare Professional Communication**). Patients mentioned challenges in reaching doctors, as responses to emails can take time due to the doctors' busy schedules. Nurses shared that consultations can be difficult when patients are fatigued from treatment, making it hard for them to complete screenings or discuss their symptoms effectively. In addition, nurses shared that some patients do not speak the local language making the communication difficult.

- *A patient described: "It's difficult [the communication with healthcare professionals] … most of the time, my oncologist answers quite quickly. But sometimes he has too many things to do."*
- *A nurse observed: "When we start therapy, we give them medication that makes them very tired and then they [the patients] don't want to complete the paper-based questionnaire."*

Patients also expressed unique needs, including managing information overload and accessing personalized, trustworthy information (**Table 1**, **Theme 3: Improving Self-efficacy and Managing Information Overload for Cancer Patients**). Additionally, they highlighted the importance of a social support system which does not only include connecting with peers in similar situations but also the continued need for in-person support from healthcare professionals (**Table 1**, **Theme 4: Need for Connection, Medical and Social Support for Cancer Patients**).

- *As one patient noted: "I have read a few things but, in the end, I was so overwhelmed with the conversations. Before each surgery, you have a conversation with the surgeon or the radiologist and then with the anesthetist and then again, a conversation and then you get a few more documents […]"*
- *Another shared: "Because now that I have this app with my illness, it's good, but it brings everything virtual, and you need to connect with people in real life".*

Generative Phase

Integrating Digital Health in Cancer Supportive Care: Proposal from the Research Team for the OncoSupport+ App

Based on the current process for supportive care and the previously highlighted challenges and opportunities for digital health, the research team proposed integrating a digital health app, named OncoSupport+, into the cancer supportive care journey (Figure 2). The app includes a set of functionalities and features designed to address needs specified in the previous paragraph. OncoSupport+ can be used by both patients and cancer nurses, with different functionalities tailored to each user group.

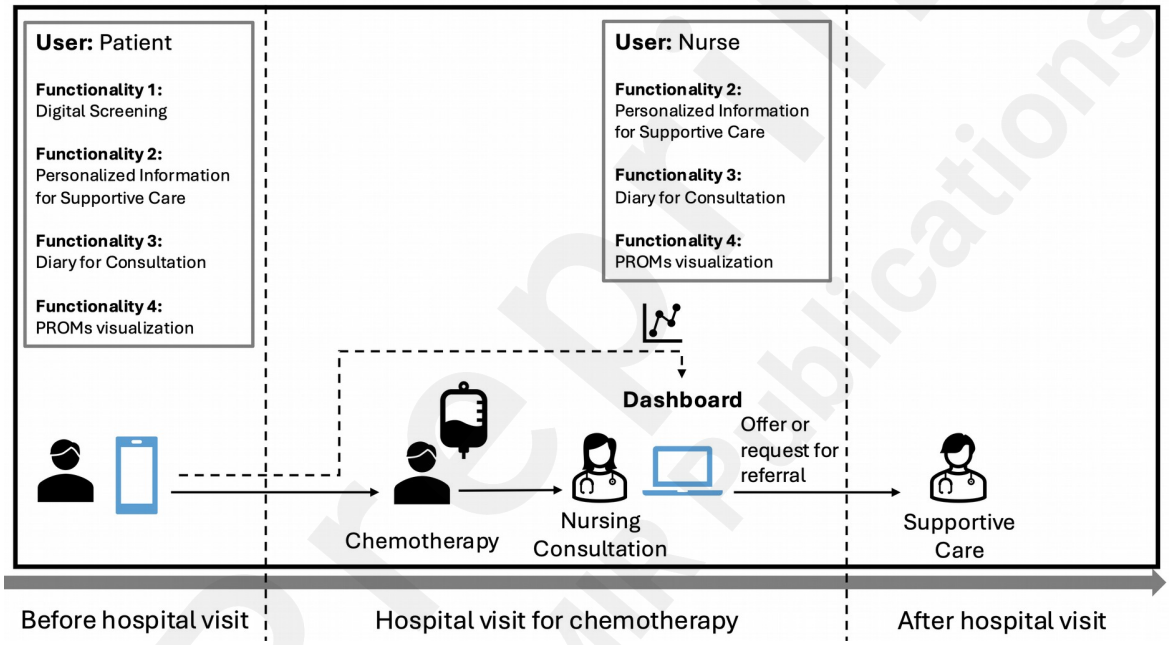

Figure 2: Patient Journey Map for Supportive Care with OncoSupport+ Digital Health Intervention and user-based Functionalities (PROMs = Patient Reported Outcomes Measures)

In summary, OncoSupport+ is designed that patients can use it in the week prior to their nursing consultation. This allows for digital screening, including the Distress Tool and EORTC QLQ-C30 assessments (Functionality 1: Digital Screening), to be completed before the appointment. OncoSupport+ also provides a comprehensive list of supportive care services available at the University Hospital Zurich (USZ), complete with contact information. The app offers personalized information for the most relevant services (Functionality 2: Personalized Information for Supportive Care) based on symptoms and needs identified through the digital screening.

Additionally, the app features a diary functionality that allows patients to note symptoms not captured by the digital screening or to write questions for discussion during their consultation (Functionality 3: Diary for Consultation). It also includes a visualization tool for PROMs (Functionality 4: PROMs Visualization).

During the consultation, nurses can access OncoSupport+, search for the specific patient, and view the PROMs (Functionality 4: PROMs Visualization). They can also review the notes entered by the patient in the diary and the supportive care services offered by the app (Functionality 2, Functionality 3).

A rule-based algorithm was developed together with supportive care specialists at the hospital. This algorithm prioritizes supportive care services and provides personalized information based on the symptoms and needs reported by patients and is based on medical knowledge and published scientific literature. For example, the psycho-oncology service may be prioritized if a patient reports a distress level above a threshold of 5 on a scale between 1 and 10 and rates one of the emotional functioning and social functioning questions as ‘very much’ (See Multimedia Appendix 2 for a detailed description of the rule-based algorithm). Additionally, specific questions were added to the PROMs collected at the hospital to support nursing consultations and enhance the personalization of information (See Multimedia Appendix 4 for an overview of digital screening questionnaires).

Patient Perspectives on the Digital Health App OncoSupport+

Figure 3 illustrates patient perspectives on OncoSupport+, highlighting their feedback on proposed functionalities from the research team (Figure 3) and suggestions for additional functionalities not initially included in the app (Figure 4).

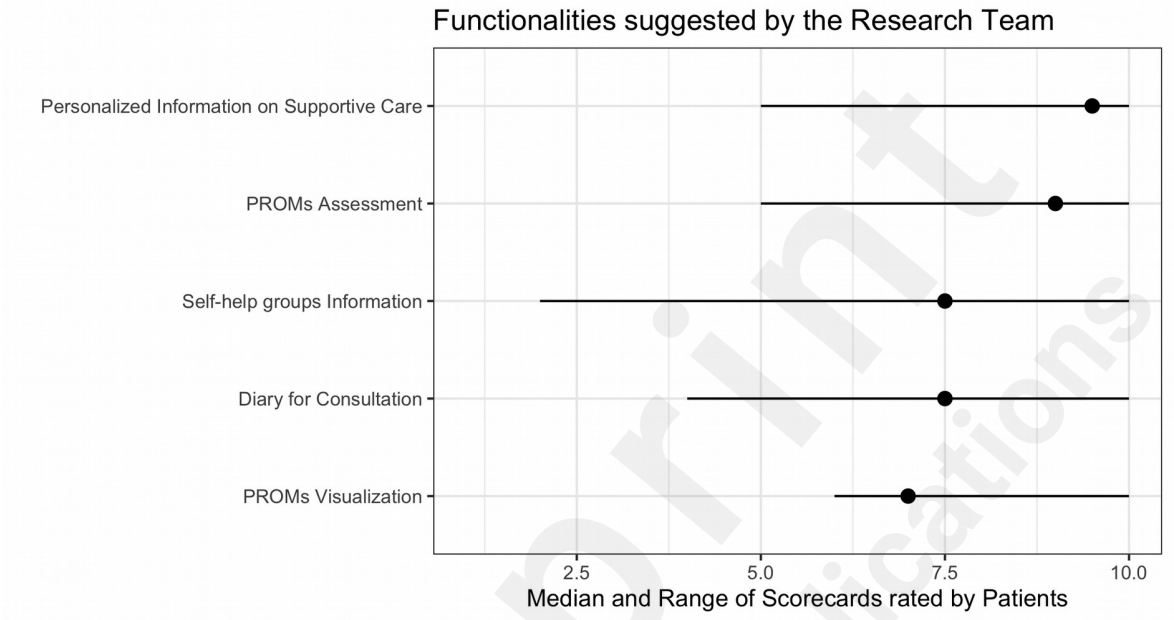

Figure 3: Patient perspectives on Digital Health Functionalities - Functionalities suggested by the Research Team and rated by Patients

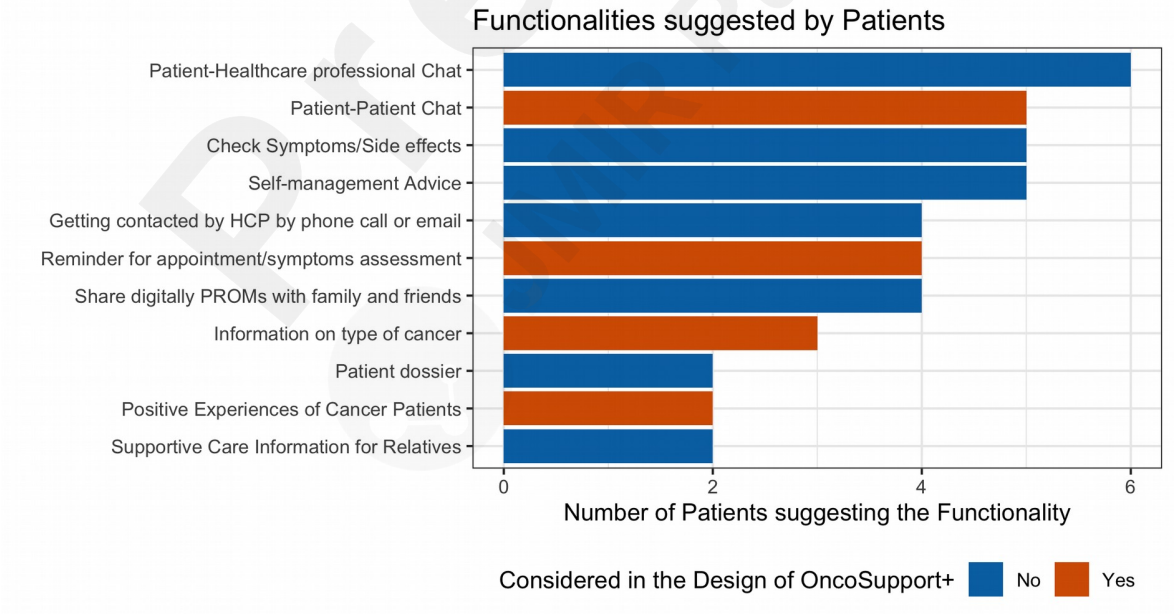

Figure 4:Patient perspectives on Digital Health Functionalities - Functionalities Suggested by patients

On a scale from 1 to 10, where 10 represents "must-have functionality," all functionalities had a median score above 7. However, ranges in such scores were high with the lowest score rated as 2 and the highest as 10. Patients rated personalized information on supportive care as the most important feature (median = 9.5), followed by Digital Screening (i.e., Patient-Reported Outcome Measures assessment; median = 9).

Self-help group information and a diary for consultation were considered less important (median = 7.5), as some patients already use paper-based diaries. The visualization of PROMs assessments was rated with a median of 7. While some patients found it very important to visualize their symptoms to track improvement or deterioration, others emphasized the importance of interpreting such data in collaboration with healthcare professionals.

Patients also suggested additional functionalities to enhance the app (Figure 4). The most frequently suggested feature was a patient-healthcare professional chat, proposed by six patients. Five patients suggested a patient-patient chat, a symptom-checking tool to assess whether symptoms and side effects require medical attention, and self-management advice.

Four patients proposed features that enable healthcare professionals to proactively contact patients via phone or email if symptoms worsen, along with reminders for consultations with nurses or symptom assessments and a functionality to share data with family and friends. Additionally, two or three patients suggested providing information about cancer types, sharing positive experiences from other patients, and offering supportive care information for relatives.

Of the suggested functionalities by patients, four were considered while the others were not as they were not in line with the scope of this project or may be in contrast with this project Medical Device Regulation strategy (i.e., the app is not a medical device). Specifically, the functionalities considered and added were: a link to the patient-patient chat from Krebsliga patient association (Functionality 5: Krebsliga patient-patient chat), reminder for following appointments and to fill-out the digital screening (Functionality 6: Digital Screening and Appointment Reminder), information on cancer type (Functionality 7: Cancer Type Information), a link to past experiences and stories of cancer patients (Functionality 8: Stories of Cancer Patients).

Factors potentially impacting on the uptake of the Digital Health App OncoSupport+

When explored factors which may impact on future acceptance of OncoSupport+, the UTAUT2 model was used to map themes identified and they are summarized in Figure 5 (Multimedia Appendix 1 shows supporting quotes). A key factor in performance expectancy appears to be improved patient-healthcare professional communication, as highlighted by both patients and cancer nurses. While nurses anticipate that the app may be a useful tool to enhance the digitalization and standardization of supportive care, patients are likely to expect personalized information and emotional support. Social influence appears to be an important factor, with patients more likely to accept OncoSupport+ when a healthcare professional introduces the app to them and when they agree to fill out the digital screening during their appointment. Furthermore, an easy-to-learn and use app with a simple user interface that accommodates the skills of older people seems to be an important aspect that may enhance behavioral intention. The integration of OncoSupport+ within the nursing consultation process and the provision of technical support to users when needed may serve as facilitating conditions that mitigate the effort expectancy. However, internet anxiety, which includes concerns about privacy and transparency and mistrust in digital health technology, may hinder acceptance and moderate the relationship between social influence, effort expectancy, and behavioral intention.

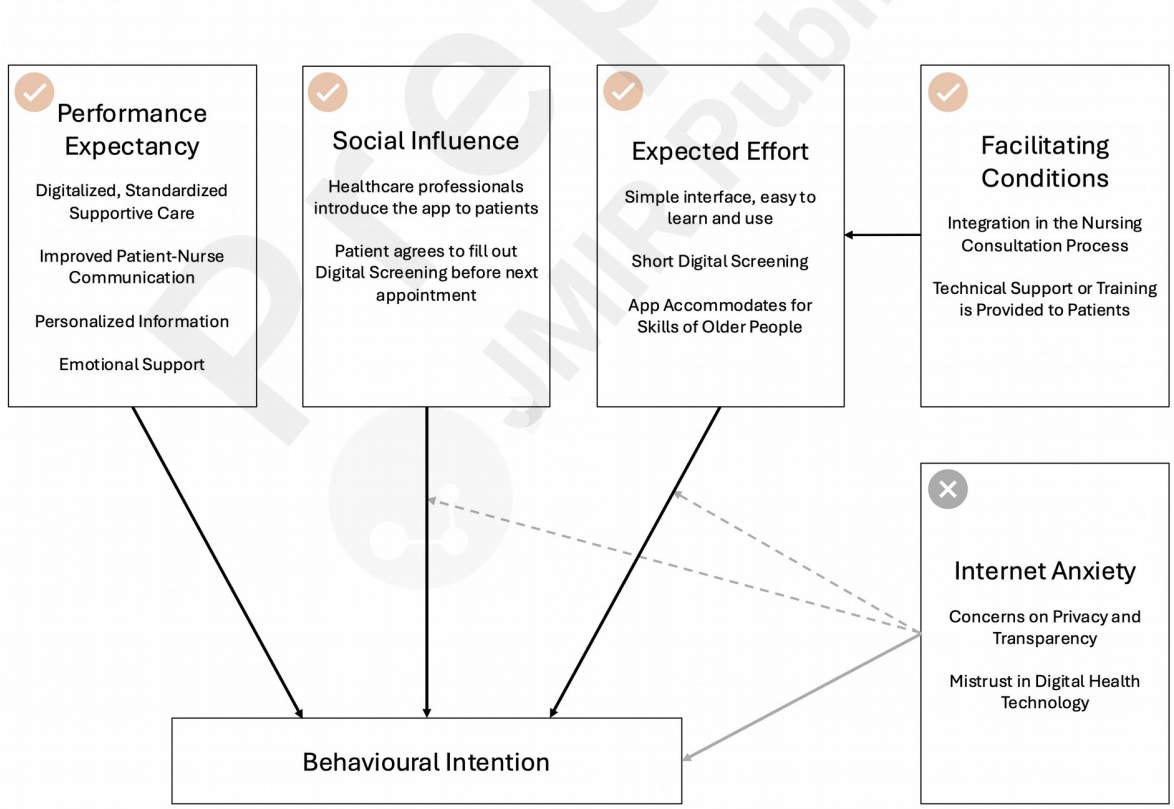

Figure 5: UTAUT2 model to explain factors impacting on acceptance of OncoSupport+: performance expectancy, social influence, expected efforts positively correlate behavioral intention (black lines), Internet anxiety negatively correlates behavioural intention (grey line) and moderates social influence and expected effort (grey dotted line).

Prototyping

Considering previous steps, a prototype was iteratively developed. First, a user flow was created and tested to check the journey in the app from the registration and onboarding to the use of the main functionalities explained in the previous paragraphs (Multimedia Appendix 3, Figure C1). Second, a higher fidelity prototype was developed and iteratively tested to adjust requirements, text and the user interface. Prototypes can be found in the Multimedia Appendix 3; Figure 6 shows the high-fidelity prototype with the two main functionalities (i.e., digital screening, personalized information on supportive care). Considering factors impacting the acceptance summarized in the previous paragraph, the developed app designs are simple and user-friendly to meet the needs of cancer patients. Additionally, to meet the performance expectancy and privacy concerns, a benefit of using the app section was created in the landing page of the app where improving the communication between the healthcare professionals and patients was listed as a central benefit. More details on the user interface development can be found in Multimedia Appendix 3, while more details about the IT infrastructure can be found in Multimedia Appendix 5.

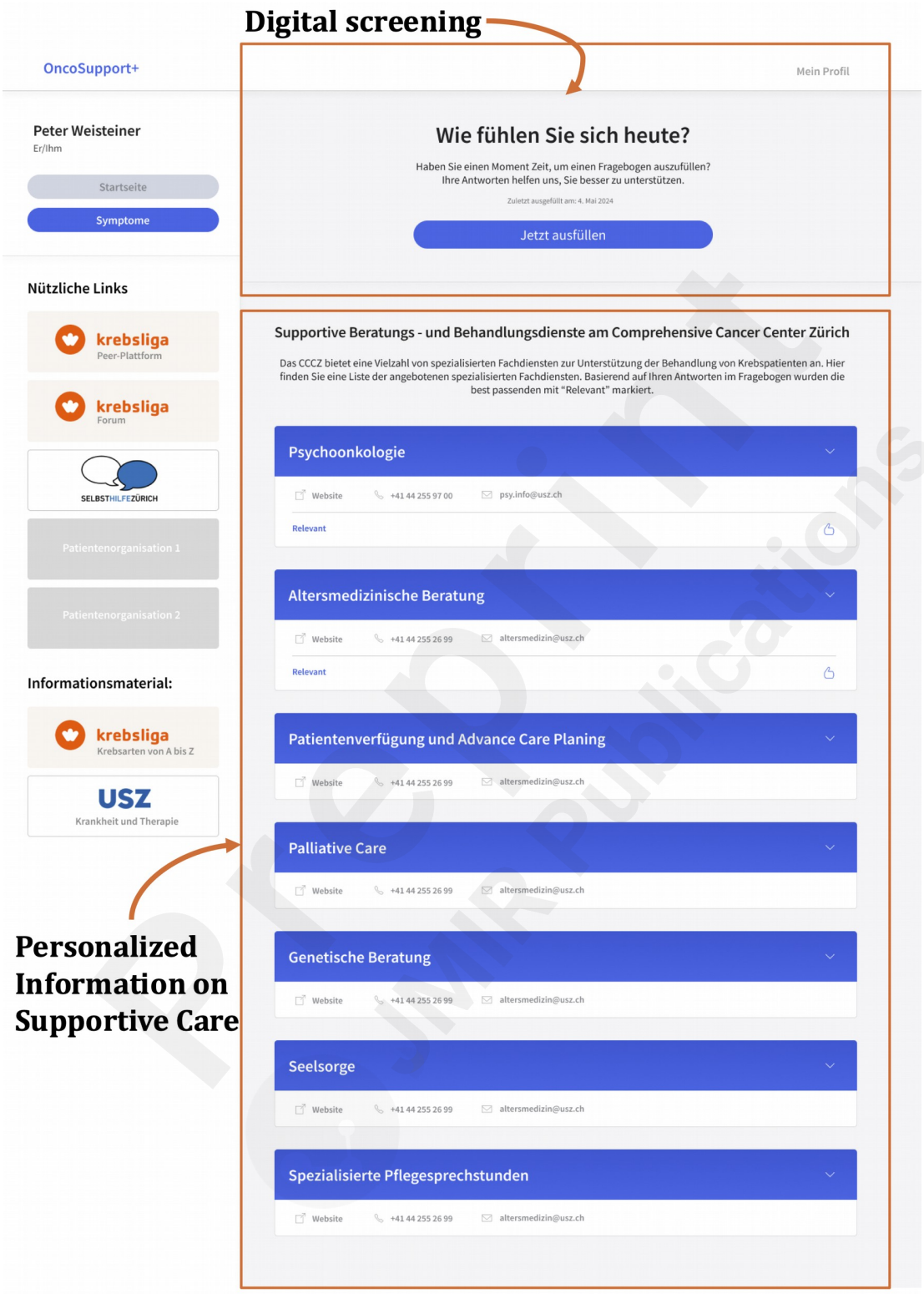

Figure 6: high-fidelity prototype showing the digital screening functionality and the personalized information on supportive care functionality

Discussion

Principal Results

This study highlights the importance of collaboratively designing and developing digital health apps and interventions in partnership with the main users (healthcare professionals and patients). This approach identifies how digital health technology can most benefit patients and healthcare professionals at the University Hospital of Zurich and beyond and highlights potential factors that may impact adoption and implementation. As improving patient-healthcare professional communication and, standardization and digitalization of supportive care were primary challenges, the OncoSupport+ app was co-designed to be integrated into the supportive care journey with the digitalization of Patient-Reported Outcome Measures (PROMs) screening. Furthermore, as patients seem to find important enhancing their self-efficacy, managing information overload, and feeling supported by their peers and healthcare professionals, OncoSupport+ prepares patients for in-person nursing consultations by providing personalized information, access to supportive care services, and links to self-help groups, patient-to-patient chats, and stories from other cancer patients. These features may prepare patients effectively for consultations, thereby improving the overall quality of the interaction between patients and healthcare professionals and their sense of empowerment. While meeting the performance expectations of patients and healthcare professionals is a primary driver for the uptake of the technology[23], the development of an easy-to-use app, its introduction by healthcare professionals, and the provision of technical support may be critical for improving overall adoption. However, concerns related to interacting with a digital environment (e.g. internet anxiety) may hinder this adoption. Future usability and feasibility studies will further evaluate the implementation feasibility, real-world usability and acceptance of OncoSupport+ in clinical practice.

Comparison to prior work

The challenges identified in this study highlight the critical role of communication between patients and healthcare professionals, a domain where digital health technologies may play an important role. These technologies are not intended to replace healthcare professionals but rather to enhance and facilitate interactions with patients [26]. Consistent with previous research and systematic reviews[3], effective communication has been recognized as a key supportive care need. Not surprisingly, effective communication in cancer care has long been associated with improved medical and psychosocial outcomes, including reduced distress and increased satisfaction for both patients and clinicians [27]. Moreover, the European Society for Medical Oncology (ESMO) supports the integration of digital symptom monitoring, including the assessment of Patient-Reported Outcome Measures, as a vital element of cancer supportive care [28]. Evidence suggests that the use and digitalization of PROMs significantly enhance communication between patients and healthcare professionals [29]. For instance, a systematic review by Yang et al. (2018) [29] suggests several mechanisms through which PROMs

influence communication. These include increasing symptom awareness for both patients and healthcare professionals, prompting discussions (e.g., addressing patient fears or uncertainty about disclosing symptoms), streamlining consultations (e.g., using PROMs as a guide to direct healthcare professionals toward key patient-reported symptoms), and facilitating inter-professional communication between healthcare professionals (e.g., enabling standardized patient tracking and optimizing the transfer of information). These mechanisms illustrate how PROMs may be a valuable tools for improving the quality of communication and, thereby potentially enhancing clinical outcomes.

The findings of this study suggest that improving empowerment and self-efficacy in cancer patients may be an important aspect of digital interventions in supportive care, consistent with previous research in this field. Recent systematic reviews[30,31] have indicated that digital health interventions, such as mobile applications and web-based platforms incorporating educational resources, interactive tools, medication reminders, and self-management features, may encourage patients to actively engage in their healthcare by enhancing empowerment and increasing self-efficacy. This enhanced sense of empowerment has been associated with better adherence to treatment regimens and more proactive health behaviors [31]. However, while digital health interventions that incorporate educational resources and self-management tools have been more consistently associated with increased self-efficacy, their direct impact on clinical outcomes such as symptom reduction and improvements in quality of life remains inconsistent across studies[32]. Although OncoSupport+ includes features related to informational and educational resources, appointment reminders, and tools to facilitate patient interaction, future research may explore the integration of self-management advice for symptom management to further enhance patient empowerment [33]. Additionally, while chat functions and telemedicine tools could further improve communication and self-efficacy, these features were not feasible for implementation in OncoSupport+. As patients value such tools, future research may focus on exploring the role of telemedicine solutions or AI-based chatbots in enhancing patient outcomes.

The digitalization of supportive care screenings and processes presents both significant opportunities and considerable challenges for hospitals. Digital transformation is reshaping healthcare by enhancing clinical workflows and promoting patient-centered care [34]. Implementing digital tools can improve efficiency and the quality of care, thereby reducing waste in healthcare costs. For instance, as reported by healthcare professionals interviewed in our participatory study, a separate study has shown that digital questionnaires significantly reduce the administrative burden on nurses compared to traditional paper-based questionnaires, allowing them to dedicate more time to patient care and resulting in substantial reductions in paper consumption[35]. Similarly, the adoption of electronic health record systems has been shown to facilitate better patient data management and streamline workflows. However, the transition to digital systems is not without challenges. Hospitals often face issues such

as interoperability, strict data security regulations, the need for comprehensive staff training, and potential resistance to change among both healthcare professionals and patients[34]. And this has been shown for cancer care as well[36]. Additionally, the lack of standardization across different IT systems at the hospital can hinder the seamless integration of digital tools. For example, the unsuccessful implementation of a nationwide digital patient dossier in Switzerland highlights the difficulties associated with a fragmented healthcare infrastructure and the absence of standardized frameworks [37]. Therefore, while digitalization offers promising benefits, careful consideration and strategic planning are essential to effectively navigate the associated challenges.

This study explored factors influencing the future acceptance of digital health apps like OncoSupport+, aligning with the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, which has been validated using quantitative data from digital health interventions [23]. An interesting finding concerns internet anxiety and the observation that age does not appear to be a barrier to technology acceptance. Internet anxiety, defined as the fear or discomfort individuals experience when using online technologies, can hinder the adoption of digital health solutions[23]. Previous research indicates that while age is not a significant predictor of health technology acceptance[38], it correlates with internet anxiety—an important factor in adoption. Moreover, individuals with lower digital literacy[39] tend to exhibit higher levels of internet anxiety. However, providing adequate training and support can help alleviate these concerns, thereby enhancing the adoption of digital health technologies.

Strengths and limitations

This study has both strengths and limitations that should be considered when interpreting the results. A key limitation is the relatively small sample size (n = 10 cancer patients and advocates), which may limit generalizability. However, the inclusion of a significant number of female participants may account for gender-related biases in digital health acceptance. Additionally, the patient group may not fully represent the broader cancer population, as most participants were aged below the average age of cancer population and had a tertiary education level, higher than the Swiss national average. As education level correlates with digital literacy and and some participants were highly experienced with digital health tools, acceptance of OncoSupport+ may differ in populations with lower digital experience. While individual interviews provided valuable insights, future research may benefit from workshops involving different user groups (e.g., patients and nurses) to foster mutual understanding and refine the co-design process. A key strength of this study is the direct integration of perspectives of patients, ensuring that OncoSupport+ is aligned with user needs and expectations.

Conclusion

This study highlights the feasibility and importance of collaborative design in developing digital health applications and interventions, emphasizing the need for direct involvement of patients and healthcare professionals in the development process. The findings suggest that digital interventions such as OncoSupport+ may include features and functionalities to enhance patient-healthcare professional communication, facilitate the digitalization of supportive care screenings, and support patient empowerment and self-efficacy by providing personalized information on supportive care services, promoting connection with other patients and self-management advice. However, while OncoSupport+ appears to meet the performance expectations of both patients and healthcare professionals, future research is needed to evaluate its implementation feasibility and determine whether it can effectively improve communication, enhance self-efficacy, and ultimately lead to better health outcomes, such as improved quality of life.

Acknowledgements

We thank Helén Johanna Luedtke for her assistance with the recruitment phase at the Department of Oncology and Hematology of the Zurich University Hospital; we thank Bruno Ceolin Argenta for his help in creating Figma prototypes in the prototyping phase. We also thank the Supportive Care specialists working at the Zurich University Hospital who participated in our workshop and contributed in creating the knowledge-based algorithm: Maja Zenz, Ph.D., Prof. Dr. med David Blum, Christina Gassmann, Nicola Greco, Anastasios Manettas. This work was supported by the Digitalization Initiative of the Zurich Higher Education Institutions (DIZH).

This study utilized OpenAI's Whisper AI for transcription of qualitative data. To ensure accuracy, researchers manually reviewed and verified transcripts by cross-checking them with the original audio recordings. Additionally, AI-assisted tools were used to support language refinement and improve the readability of the manuscript. While these tools assisted in manuscript preparation, all final decisions regarding content, interpretation of results, and conclusions were made by the research team. The authors take full responsibility for the integrity and accuracy of the work presented.

Authors' Contributions

Conceptualization: CMW, MK, AW, AG, SD.
Data curation: SD, MB, CL.
Formal analysis: SD, MB.
Funding acquisition: KM, CMW, KS, SH, PA, SM, AW, AG.
Investigation: SD, MB.
Methodology: CMW, SD.
Project administration: SD.
Software: KS, CL, SH, YZ.
Visualization: SD, CL.
Writing – original draft: SD.
Writing – review & editing: MB, CL, KS, CMW, MK, AG, AW, SH, PA, SM, MR.

Conflicts of Interest

CMW has active research grants to the University for digital health projects from the DIZH, the Swiss Cancer Research foundation, the German health care Innovation Fund, and Newsense Lab GmbH and has received honoraria from Swiss hospitals for scientific presentations on the digitalization and AI in medicine. MK is co-founder and AI Advisor at Oncobit but has no conflicts of interest related to this paper. The remaining co-authors declare no conflicts of interest.

Data Availability

Data sharing is not applicable as data was collected and analyzed with the purpose of developing the digital health intervention OncoSupport+ at the University Hospital Zurich (Req-2023-01095 Clarification of Responsibility).

Abbreviations

USZ: University Hospital Zurich
mHealth: Mobile Health
PROMs: Patient-Reported Outcome Measures
MASCC: Multinational Association of Supportive Care in Cancer
EORTC QLQ-C30: European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30
UTAUT2: Unified Theory of Acceptance and Use of Technology

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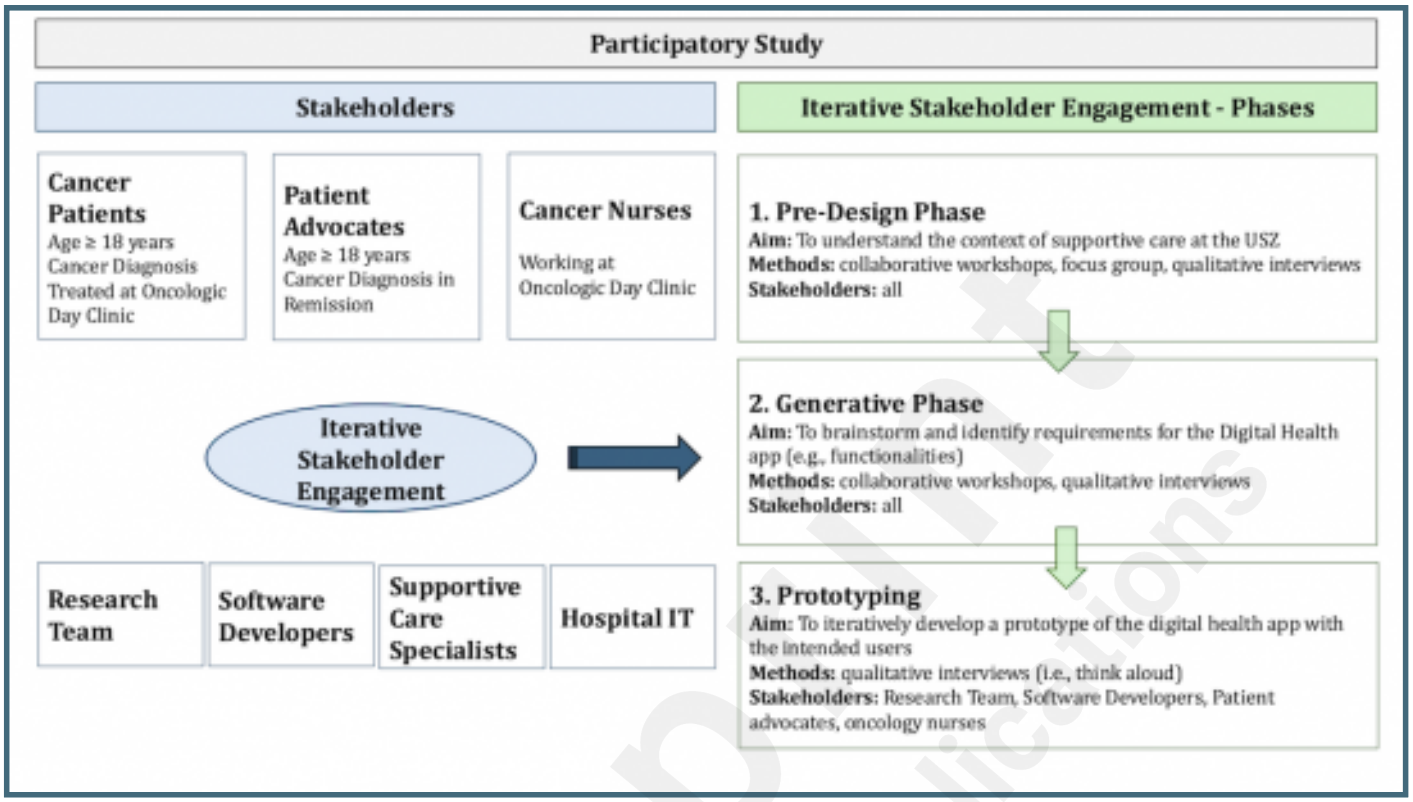
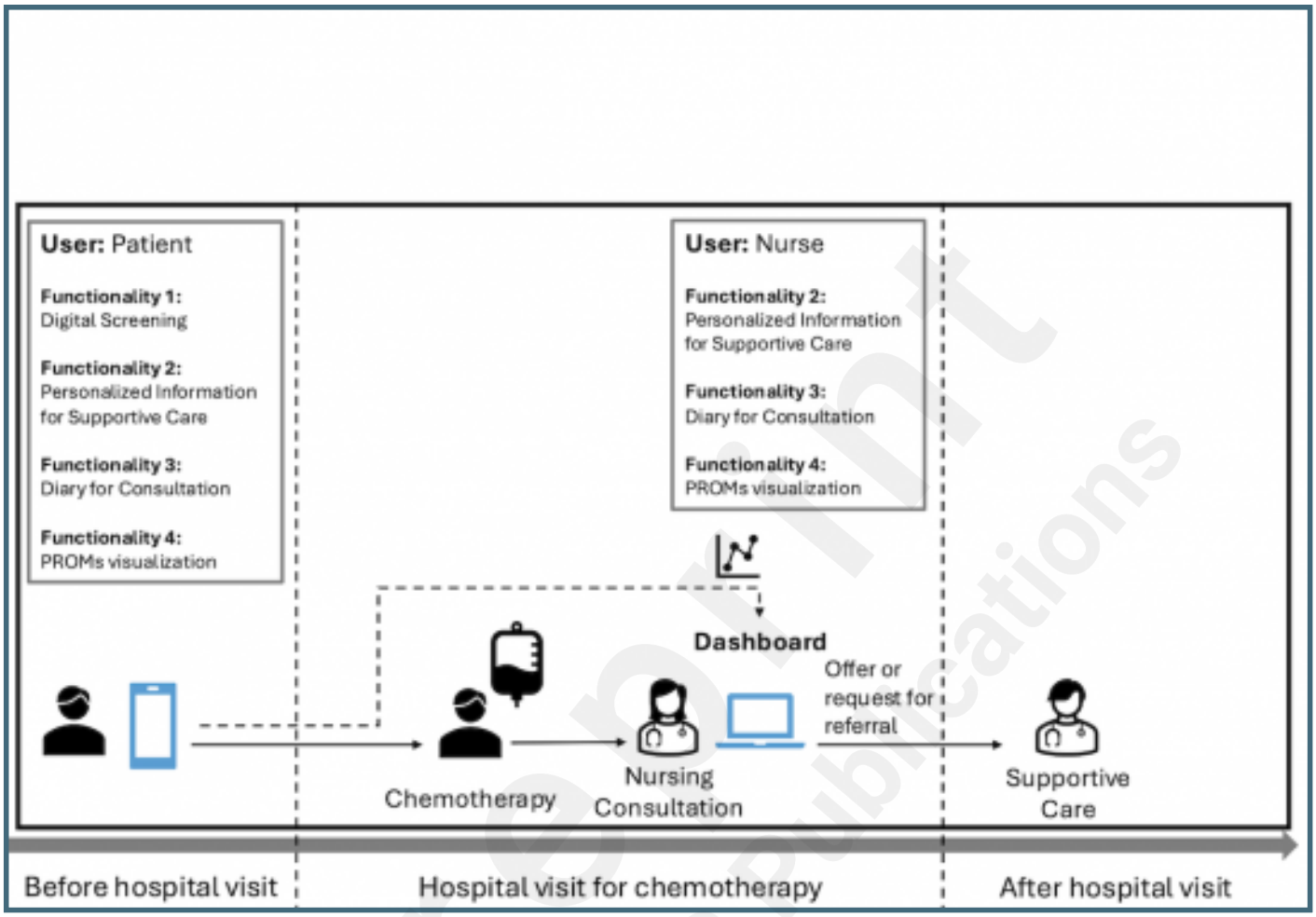
Supplementary Files

Figures

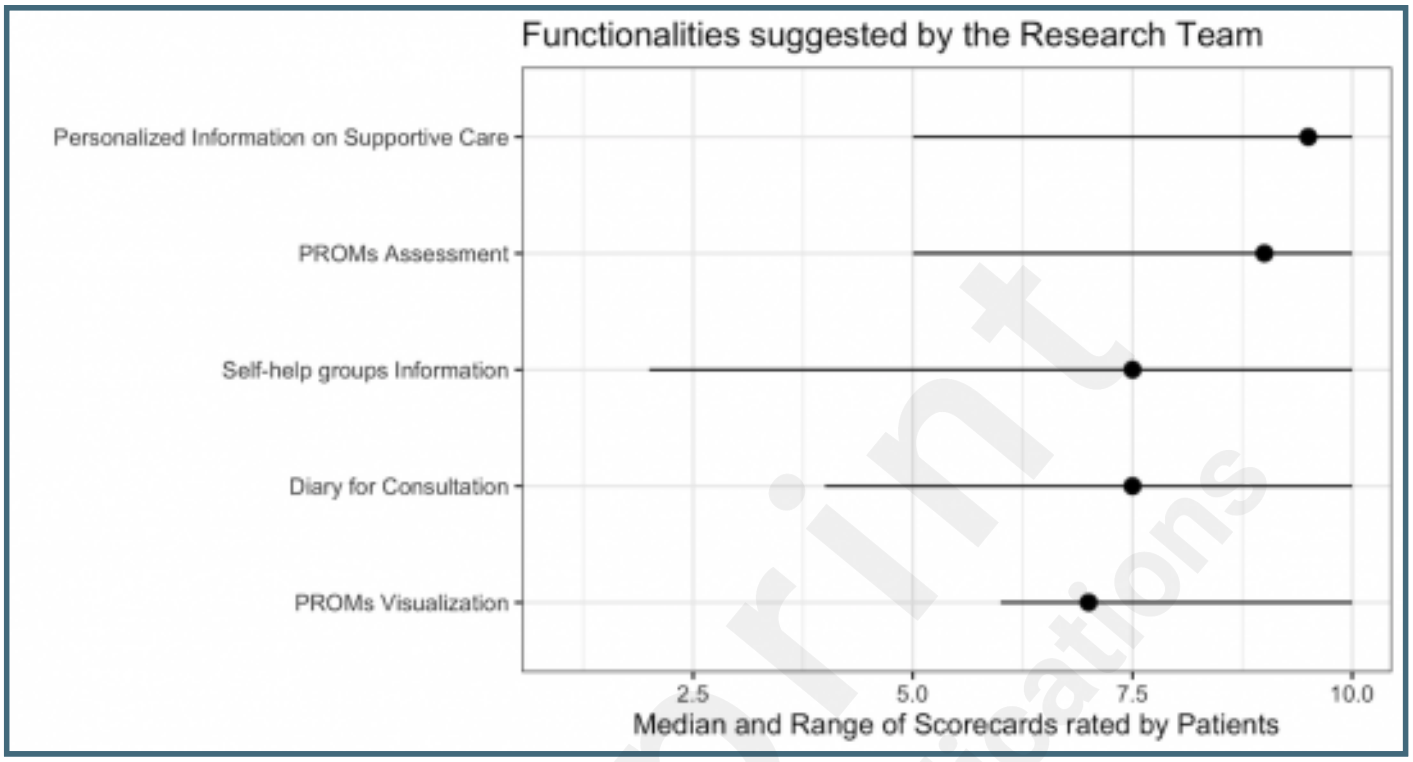
Participatory Study Design employing Iterative Stakeholder Engagement and divided in three phases (i.e., pre-design, generative and prototyping).



Patient Journey Map for Supportive Care with OncoSupport+ Digital Health Intervention and user-based Functionalities (PROMs = Patient Reported Outcomes Measures).



Patient perspectives on Digital Health Functionalities - Functionalities suggested by the Research Team and rated by Patients.



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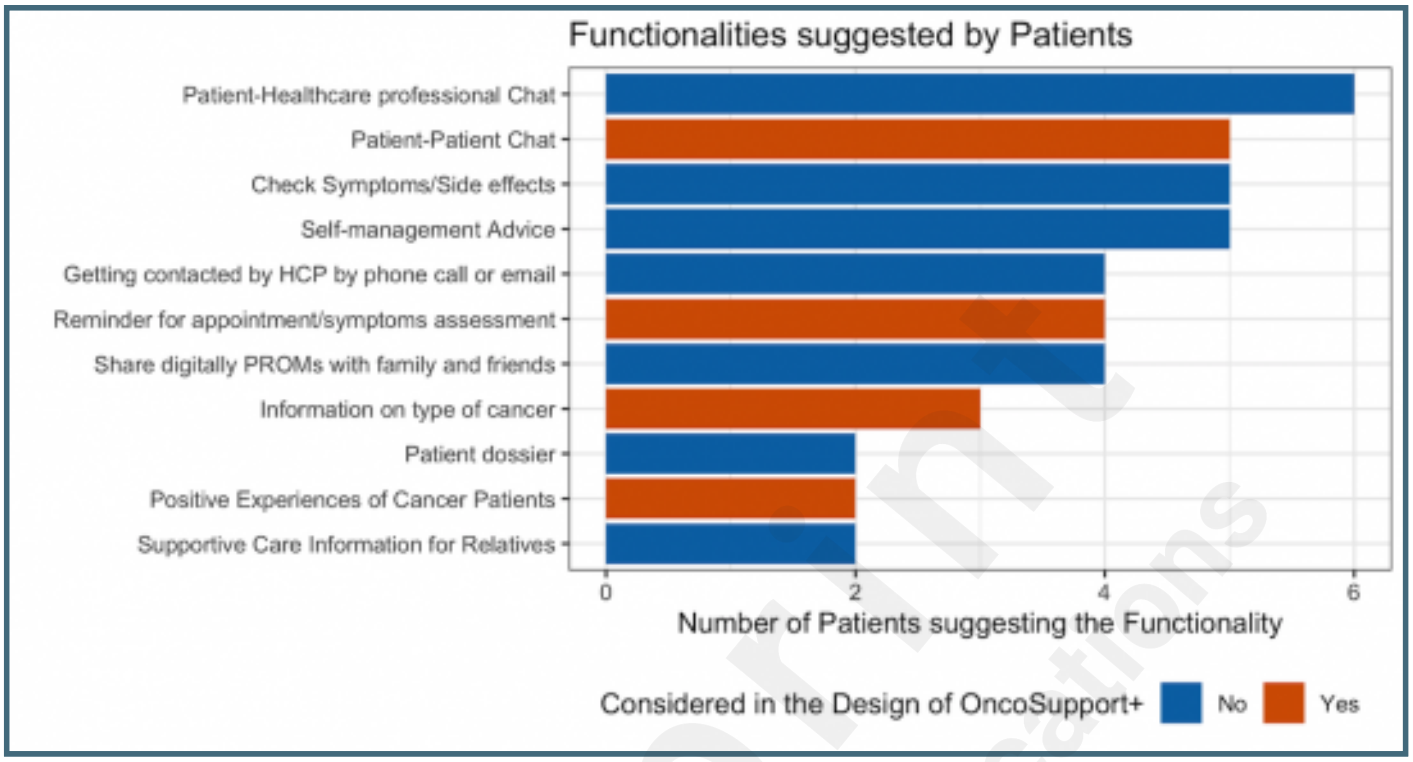

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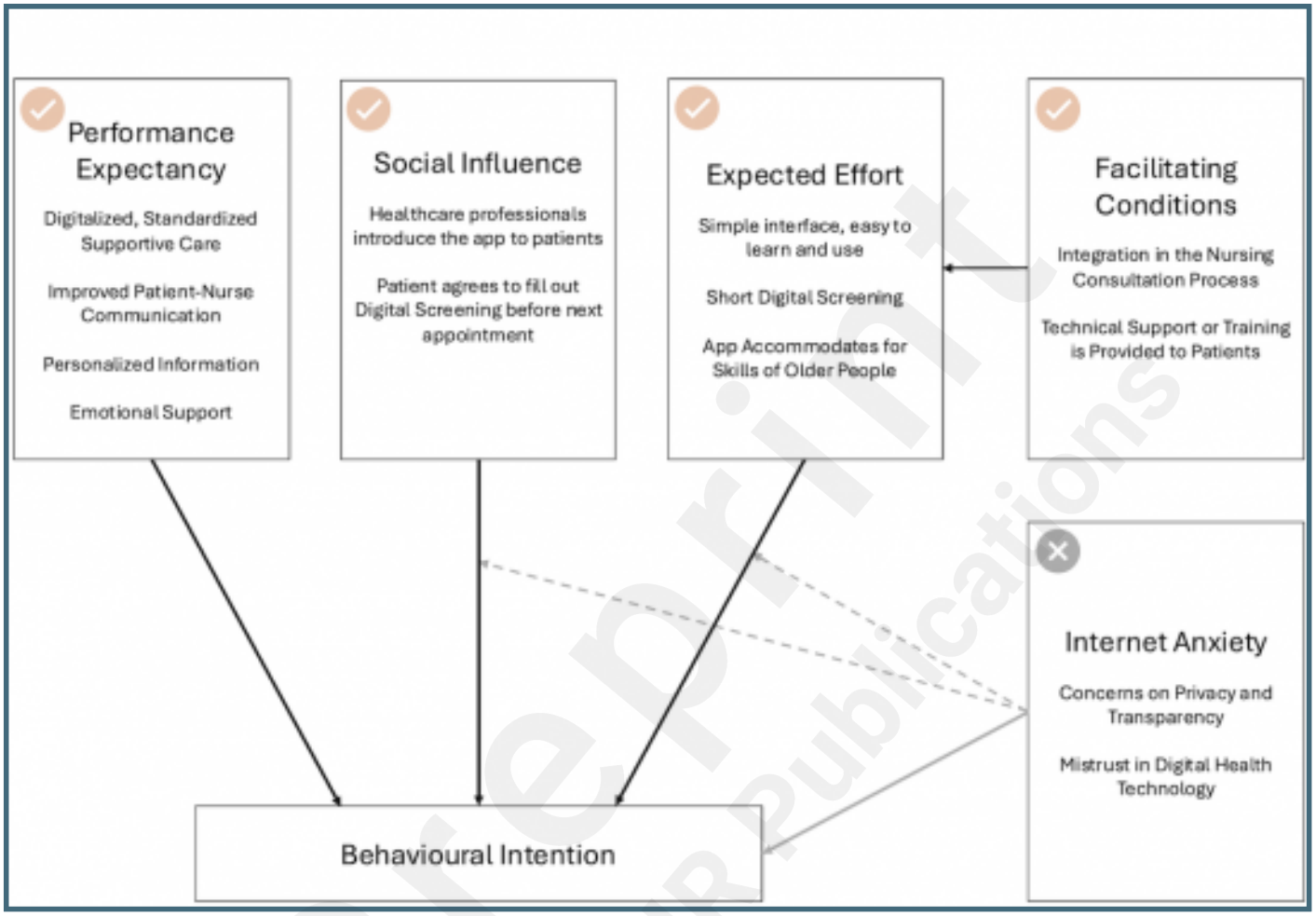

High-fidelity prototype showing the digital screening functionality and the personalised information on supportive care functionality.

Multimedia Appendixes

Thematic analysis and results.
URL: http://asset.jmir.pub/assets/31b6f4c45452eb1270acb6c47af491c8.docx

Knowledge-based algorithm to connect Patient-Reported Outcomes Measures to Supportive Care Services.
URL: http://asset.jmir.pub/assets/e3b370613cfbf5b35845a25800a80399.docx

Prototypes & User Interface Designs.
URL: http://asset.jmir.pub/assets/f0369f89af37bdbeef25635102c04a28.docx

Digital Screening questionnaires.
URL: http://asset.jmir.pub/assets/ea9f8377ee64c99a35231e0a4634f83f.docx

IT Infrastructure.
URL: http://asset.jmir.pub/assets/4034f5a153da54cc24a3b7f3894152ab.docx