Design and Evaluation of an Interactive Support System for Palliative Care

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Abstract

Palliative care professionals face complex challenges related to documentation, communication, and culturally sensitive care. This paper presents the design, implementation, and evaluation of an intelligent user interface based on a large language model (LLM) to support nurses and physicians in palliative care. Using a Rapid Contextual Design approach, semi-structured interviews with healthcare professionals were conducted to identify user needs and derive relevant use cases. Based on these insights, a user-centered, web-based prototype with voice interaction and an AI assistant was developed to provide context-aware information.An expert usability evaluation using the System Usability Scale indicated generally positive usability perceptions. The results show a mean SUS score of 78.75, indicating good usability. The findings demonstrate the feasibility of intelligent user interfaces in palliative care and provide a foundation for future real-world evaluations.

Keywords

Palliative Care, Rapid Contextual Design, Clinical Decision Support, Healthcare Technology

1. Introduction

The World Health Organization (WHO) describes palliative care as " an approach that improves the quality of life of patients and their families facing the problems associated with life threatening illness, through the prevention and relief of suffering by means of early identification and impeccable assessment and treatment of pain and other problems, physical, psychosocial and spiritual" [1]. In everyday clinical practice, palliative care professionals are confronted with complex challenges, including extensive documentation requirements, interdisciplinary coordination, emotional burden, and culturally sensitive decision-making. Cultural and religious backgrounds play a crucial role in end-of-life care, shaping communication practices, decision-making styles, and preferences regarding life-prolonging treatments and supportive care [2]. However, accessing reliable and context-specific cultural knowledge during daily clinical workflows remains difficult. Recent advances in artificial intelligence have created new opportunities for AI-infused user interfaces that support users through natural and context-aware interaction [3]. Intelligent user interfaces combine adaptive system behavior and user-centered design principles to support complex tasks through mixed-initiative interaction [4]. Prior work highlights the potential of AI-assisted systems to enhance clinical decision support [5]. In parallel, user-centered design approaches such as Rapid Contextual Design are effective in capturing real-world workflows and translating qualitative insights into practical system requirements[6]. Yet, many healthcare technologies struggle to achieve sustained adoption due to poor usability, lack of contextual fit, or insufficient consideration of users' daily practices [7]. Usability evaluation methods such as the System Usability Scale (SUS) are widely used to assess the perceived usability of interactive systems [8].

Against this background, this paper presents the design, implementation, and evaluation of an LLM-based intelligent user interface aimed at supporting palliative care professionals. The work is

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guided by three research questions: (RQ1) What challenges do palliative care nurses and physicians face in their daily workflows? (RQ2) How can an LLM-based intelligent user interface be designed using user-centered methods to support healthcare professionals? and (RQ3) How usable is the proposed intelligent user interface when evaluated using the System Usability Scale (SUS)? By addressing these research questions, this paper aims to contribute empirical insights into the design and evaluation of intelligent user interfaces for complex healthcare environments.

2. Methodology

To develop a user-centered solution, the Rapid Contextual Design method [9] was applied. As part of the data collection phase of Rapid Contextual Design, semi-structured interviews were conducted with palliative care nurses. The interview guide aimed to capture work processes, problems, and the support needed in daily practice. The interviews were then transcribed and documented in an interpretation table, through which the most important insights were identified. Based on these insights, initial use cases for an LLM-supported app were derived. The findings were additionally illustrated in a coding matrix. This supported the qualitative analysis and helped to systematically capture key categories such as work organization, emotional and general challenges, social aspects, wishes and suggestions for improvement, and technical know-how. Subsequently, the insights from the coding matrix were used to define use cases. These illustrate specific usage scenarios and translate the gained insights into useful system functions. In this way, it was ensured that the digital solution fits the respective context and can be designed in a practice-oriented manner, with the aim of optimizing information retrieval using LLMs and providing a structured patient overview to reduce workload of nursing staff.

3. Rapid Contextual Design

3.1. Interview

The interview participants recruited for this study to support a user-centred development approach were physicians and nurses. In total, five participants took part in the interviews (see Table 1). Each interview lasted approximately one hour. The interview questions were structured into several thematic areas to obtain a comprehensive understanding of the participants' perspectives. These thematic blocks comprised demographic information, daily work routines, technical integration, administrative challenges, social interaction, emotional support, team dynamics, and psychological aspects. The interviews were conducted using a semi-structured interview guide prepared in advance. At the conclusion of each interview, participants were invited to propose their own ideas for a potential tool that, in their view, could add value to their daily work. For the analysis, an interpretation table was created in which relevant statements were systematically assigned to specific question categories. The Results subsection presents the key findings across the individual thematic areas.

Table 1
Profile of Interviewees

Interviewee	Age	Profession	Experience
P1	40	Nurse	Over 2 Years
P2	70	Physician	Over 30 Years
P3	40	Nurse	-
P4	30	Nurse/Researcher	-
P5	30	Nurse	Over 13 Years

3.1.1. Results

- **Daily Work Routine:** the interviews indicate that most participants work in shift-based schedules and that effective communication in palliative care often requires the involvement of an individual with sufficient language proficiency [P2, P5]. Additionally, both nurses and physicians reported the presence of culturally influenced differences related to death, the dying process, and medical treatment, which were described as relevant for patients and their relatives [P1–P4].Specifically, participants referred to religious considerations concerning the administration of pain medication, noting instances of uncertainty or reservations regarding whether such medication should be administered and in which form [P2, P3]. Furthermore, variations in the perceived importance of nutrition were reported across different cultural contexts [P3, P4]. Handover processes between nurses were reported to occur during shift changes [P1, P3, P4]. Two participants indicated that their palliative care units had been established relatively recently [P1, P2]. In addition, some facilities were described as having comparatively adequate staffing levels [P1, P3]. Most participants reported that a substantial portion of their daily work involves direct patient care as well as communication with patients' relatives [P1–P4]. All participants indicated that documentation tasks constitute a regular part of their daily responsibilities. Furthermore, most participants reported participating in multiple team meetings on a daily basis [P1–P4].
- **Psychological Aspects:** All respondents reported generally maintaining a professional distance from patients as a coping strategy. However, maintaining this distance was reported to be more challenging in cases involving patients in comparable life situations, such as those of a similar age or analogous to close family members [P1, P2, P4]. To manage these emotional demands, some participants reported making use of supervision opportunities or engaging in discussions with colleagues to address stressful situations [P1, P2].
- **Technical Integration:** The interviews indicate that all participants either already use digital devices or are actively involved in the development of digital solutions [P1–P5]. Some participants reported using tablets in their daily work [P1,P4, P5], while all indicated having access to personal computers [P1–P5]. One deviation was reported by participant P2, who stated that, despite having access to a PC, documentation is still carried out exclusively in paper-based form. Overall, participants described themselves as average users of digital technologies, while also indicating a need for support in specific digital tasks [P1, P3]. In contrast, one participant reported a higher level of competence in electronic data processing [P2]. A wide range of digital tools and systems were reported to be in use, including Google, Orbis, Vivendi, Medico, and ISPC.
- **Administrative Challenges** Within this thematic, the interviews addressed documentation activities. As noted in the Technical Integration section, most documentation processes were reported to be carried out digitally. However, one participant indicated that documentation at their institution is conducted exclusively in paper-based form [P2]. With regard to documentation activities, the interviews showed that these tasks are perceived as time-consuming due to their frequent repetition. Participants reported a wide range of documentation processes that are regularly required in their daily work, indicating a substantial administrative workload.
- **Social Interaction:** Participants reported recurring cultural differences in communication among nursing staff, physicians, and patients. Language barriers were identified as a key challenge, often necessitating the involvement of interpreters, family members, or other individuals proficient in the relevant language to enable communication [P2, P5]. Beyond language-related issues, participants indicated an awareness of culturally influenced differences, particularly concerning death, the dying process, and medical treatment, which were described as significant for patients and their relatives [P1–P4]. Examples included religious considerations related to the administration of pain medication, where uncertainty or reservations were reported regarding whether such medication should be administered and in which form [P2, P3]. Additionally, participants noted that the importance attributed to nutrition varies across cultural contexts [P3, P4].
- **Digital Tool:** At the end of the interviews, participants were asked to describe their vision of an ideal digital tool to support their daily work. Two participants articulated concrete ideas in

this regard. Participant U2 expressed a preference for a comprehensive documentation system designed to facilitate use through features such as speech input and intelligent search functionality. Participant U5 referred to a tool intended to simplify and support direct communication with patients and their relatives.

3.2. Coding Matrix

The coding matrix was employed as a systematic approach for analysing the interview data. In this study, eight main categories were derived from the interviews based on the interview guide, each comprising several subcategories. For certain main categories, such as Social Aspects, up to eight additional subcategories were identified. Each main category and subcategory was defined and supported by illustrative examples in the form of direct quotations from the interviews.

The resulting main categories of the coding matrix were work organization, emotional challenges, social aspects, administrative challenges, wishes and suggestions for improvement, career path, personal development, and technical know-how. A detailed interpretation of the interview data is presented in Phase 1; therefore, the results of the coding matrix are not described in detail in this subsection. Overall, most responses were associated with the thematic areas of work organization and social aspects. Finally, potential use cases for the app to be developed were derived from the categories of the coding matrix. The development of these use cases was carried out in the subsequent phase of the conceptual design.

3.3. Use Case Development

The use cases were tailored individually to each interview participant and covered all areas of the coding matrix. Using this approach, a total of 30 use cases were identified. Some use cases showed thematic overlap, such as the desire for voice-based documentation [P3, P4, P5] and the broader need for improved documentation capabilities [P3, P4, P5]. Due to the large number of identified use cases, a prioritization step was conducted in which the two most relevant use cases were selected for each interview participant (see table 2). Based on the resulting ten prioritized use cases, four following final use cases were identified:

Table 2
Use cases of the interviewees

Use cases	P1	P2	P3	P4	P5
Use case 1	Efficient communication of work schedules	Automated speech-based documentation	Digitization of the patient admission process	Training sessions and workshops for nursing staff on dealing with death and dying	Direct communication with patients, physicians, or relatives via an app
Use case 2	Efficient digital information source regarding cultural and religious differences	Central patient records for seamless team coordination	Simplification of the process for procuring nursing care supplies	Support for educating relatives about home-based care, e.g., handling emergencies	Support for on-boarding and familiarization with new technologies

- **Use Case 1:** Automated speech-based documentation in palliative care aims to support the documentation process by enabling voice input. The objective is to allow reports to be created directly during patient care and to automatically structure the recorded information. This approach is intended to reduce time expenditure, improve data quality, and support clinical

decision-making processes. The implementation is based on a secure and integrated speech recognition solution.

- **Use Case 2:** The centralized patient record supports team coordination through a cloud-based platform. Relevant patient data are structured and made available in real time to authorized users. This approach is intended to reduce information gaps, communication challenges, and potential sources of error. In addition, the digital record supports more efficient workflows and informed treatment-related decision-making.
- **Use Case 3:** The patient admission process is supported through a digital tool aimed at increasing efficiency. Manual data entry is replaced by a user-friendly, voice-controlled input mechanism. All relevant information is stored centrally and made available in real time, with the intention of reducing errors and waiting times. This approach is designed to free up time for personalized patient care.
- **Use Case 4:** The digital information source is intended to support nursing staff in considering cultural and religious differences in palliative care. It provides timely access to validated information to support culturally sensitive communication and care practices. This approach aims to reduce misunderstandings and support the quality of care. In addition, the platform is designed to promote intercultural competence and support the development of patient trust.

3.4. Storyboard

Based on the defined use cases, a storyboard (Figure 1) was developed to inform the systematic design of the application. The focus of this work is placed on developing an application that primarily implements Use Case 4, namely an LLM-based assistant designed to answer culture-related questions. In addition, the patient admission process was retained in order to provide the data basis for the assistant. Elements from Use Cases 1 and 2 remained included in a reduced form. Instead of verbal interaction with the patient record itself, this functionality was integrated into the assistant, enabling spoken interaction with an AI assistant. Furthermore, the application was designed to allow multiple users to access the data simultaneously.

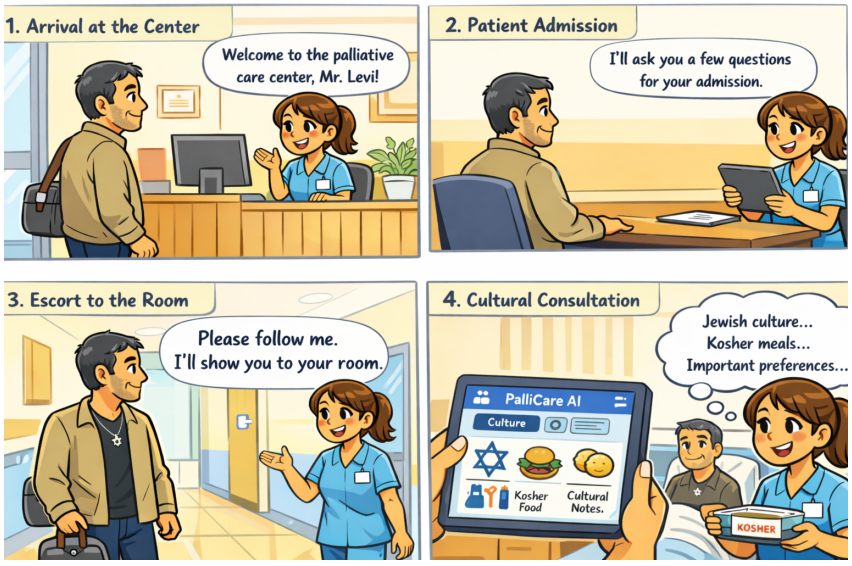

Figure 1: Storyboard. (1) Arrival at the palliative care center: Mr. Levi (middle-aged, Jewish) enters the reception area of the palliative care center. Nurse Anna (late 20s, christian) warmly greets him from behind the reception desk. (2) Patient admission: Nurse Anna goes through all the questions of the admission process and saves the answers on a tablet. (3) Escort to the patient's room: Nurse Anna walks alongside Mr. Levi and guides him to his room. (4) Using the app for cultural knowledge: Nurses check the "Culture" tab in the "PalliCare AI" app. The screen displays information on Jewish cultural and dietary guidelines (e.g., kosher meals).

3.5. Development

3.5.1. Frontend

The frontend of the application was implemented using React in combination with Vite to support efficient development processes. The system was designed as a web-based application to ensure cross-platform compatibility across contemporary operating systems, enabling access from a wide range of devices independent of the underlying platform. The application provides an intuitive user interface intended to support efficient management of patient data as well as the retrieval of information related to religious and cultural topics. Upon launching the application, users are presented with a login page. The home view serves as a central overview and displays all patients registered in the system (Figure 2, Home). A search function allows users to filter patient records by name. Data entry is performed within a document-oriented view that provides multiple input fields. In addition, the application allows a patient photograph to be captured and stored using the device's camera. After completion of the data entry process, the newly added patient record automatically appears in the overview list. Selecting a patient entry opens a detailed view in which relevant information—such as symptoms, allergies, and other health-related data—is presented in a structured manner (Figure 2, Detail View). The detail view also includes access to a digital assistant (Figure 2, Assistant), which can be activated by swiping to the left. In this mode, the patient's personal information remains visible while users can initiate voice-based interaction via a microphone button. Spoken input is transcribed and can be accessed as text or audio. Interaction with the assistant is presented in a chat-like format to support intuitive use. The digital assistant provides information in response to common questions posed by nursing staff and generates responses based on its underlying knowledge base as well as the information stored in the patient record.

3.5.2. Backend

The developed backend comprises three primary functional components: a REST API responsible for receiving and routing requests from the frontend, a database for the persistent storage of patient data, and a set of neural network–based components for data processing and analysis. The entire backend is deployed within a Docker Compose environment, which facilitates service orchestration, isolation, and simplified management of the individual components. The REST API serves as the central interface of the backend and provides access to both the database and the neural network services. It was implemented in Java using the Spring Boot framework, enabling a modular and scalable backend architecture. Patient data are stored in a PostgreSQL database, selected for its compatibility with the Jakarta Persistence API. Speech-based interaction within the system requires both speech-to-text and text-to-speech capabilities. Spoken input is processed using OpenAI's Whisper model (small variant), while spoken output is generated using Google's text-to-speech service, enabling verbal interaction within the application. In addition, a large language model is integrated to process patient-related data and user queries through prompting. For this purpose, Google's Gemma 3 model (1B variant) was selected. The choice of the Gemma 3 1B model, Whisper Small, and the externally hosted Google Text-to-Speech service was guided by the requirement that the system be deployable on consumer-grade hardware.

4. Evaluation

To evaluate the developed application, an expert evaluation was conducted. The evaluation involved experts in the field of user experience and user interface design (UX/UI), who assessed the application with regard to its general usability. In total, twelve experts participated in the evaluation. Approximately half of the participants were students who had completed a Bachelor of Science in Human–Computer Interaction or a closely related degree program. The remaining participants were industry professionals with several years of experience in software development, particularly in frontend development. Each evaluation session began with a brief introduction to the project, including an overview of the identified

(a) Login screen (b) Patient List (c) Patient Record

(d) Patient Profile (e) Chatbot

Figure 2: Overview of the screens of the app.

problem and the functionalities implemented to address it. Subsequently, participants were asked to create a fictional patient within the application. After completing the patient creation task, participants were asked to interact with the system and pose patient-related questions. Following this interaction phase, participants were asked to rate the usability of the application using the System Usability Scale (SUS). The SUS comprises ten items that yield an overall usability score ranging from 0 to 100, with higher scores indicating greater perceived usability. An overview of the SUS results is provided in Table 3.

Table 3
SUS Evaluation of System Usability (Rating scale: 1 = strongly disagree, 5 = strongly agree)

Statement	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Average
1. I can see myself using the system regularly.	2	3	2	1	1	2	2	3	2	1	5	4	2.33
2. I perceive the system as unnecessarily complex.	1	1	3	2	3	1	1	1	2	2	2	1	1.67
3. I perceive the system as easy to use.	4	3	4	5	3	3	4	5	5	4	4	4	4.00
4. I believe that I would require technical support to use the system effectively.	1	2	1	1	1	1	2	1	2	2	2	1	1.42
5. I perceive the system's various functions as well integrated.	4	4	4	4	4	4	3	4	3	5	5	3	3.92
6. I perceive the system as containing too many inconsistencies.	1	1	2	1	1	2	1	1	2	2	2	1	1.42
7. I believe that most users would learn to use the system very quickly.	5	4	5	4	4	4	4	5	5	5	5	5	4.58
8. I perceive the system as cumbersome to use.	1	1	2	1	1	2	1	1	2	1	1	1	1.25
9. I felt confident while using the system.	4	3	4	4	4	4	4	4	5	3	3	3	3.75
10. I needed to learn many aspects of the system before I could begin working with it.	1	1	1	2	2	1	2	1	1	1	1	2	1.33
SUS-Score	85	77.5	75	77.5	70	75	75	90	77.5	75	85	82.5	78.75

The expert evaluation indicates that the developed application demonstrates high overall usability. Based on the collected ratings, an average SUS score of 78.75 was obtained. According to the evaluation scale proposed by [10], this value can be classified as "good" to "excellent" usability, suggesting that the application is well designed from a UX/UI perspective.

Across individual SUS items, experts consistently rated the system as easy to use (Statement 3, M = 4.00) and quick to learn (Statement 7, M = 4.58). These results indicate that the interaction design is intuitive and that users can rapidly become familiar with the system without extensive training. This finding is further reinforced by the low agreement with statements related to complexity (Statement 2, M = 1.67), inconsistency (Statement 6, M = 1.42), and the need for technical support (Statement 4, M = 1.42).

The perceived integration of system functions was rated positively (Statement 5, M = 3.92), suggesting that participants experienced the application as coherent rather than fragmented. In addition, participants reported a relatively high level of confidence while using the system (Statement 9, M = 3.75), which is an important indicator for acceptance in professional healthcare contexts.

One comparatively lower-rated item concerns the intention to use the system regularly (Statement 1, M = 2.33). This result is not necessarily an indication of poor usability; rather, it may reflect the expert-based nature of the evaluation and the fact that many participants were not part of the actual target user group (e.g., healthcare professionals working in palliative care). As such, limited perceived relevance to their own daily work may have influenced this rating. The relatively low intention for regular use highlights a known limitation of expert evaluations: usability can be assessed effectively, but long-term acceptance and perceived usefulness should be validated with actual end users (e.g., nurses or caregivers in palliative care).

Overall, both student experts with HCI backgrounds and industry professionals provided consistent

usability ratings, indicating that the system meets established usability standards across different levels of professional experience. Given the strong usability results, the system appears sufficiently mature for subsequent evaluations involving real-world users. Future studies can therefore focus less on basic usability issues and more on contextual integration, trust, and impact on care quality.

5. Conclusion and Future Work

This paper investigated the daily work practices in palliative care and demonstrated that healthcare professionals face persistent challenges in areas such as documentation, information access, communication, and culturally sensitive care. This work complements prior research that has primarily focused on conceptualizing the potentials, challenges, and ethical considerations of speech-based assistants in palliative care [11], by presenting an applied, user-centered implementation alongside an initial empirical usability assessment. Furthermore, our work complements prior research on healthcare dialogue systems for professional users [12] by extending dialogue support toward LLM-based, context-aware interaction. Through a user-centered design process grounded in Rapid Contextual Design, key needs of palliative care nurses and physicians were identified and translated into concrete use cases. Based on these insights, an intelligent user interface integrating a large language model was designed and implemented to support culturally informed decision-making and patient-centered care. The evaluation with UX/UI experts yielded a System Usability Scale score of 78.75, indicating good usability and suggesting strong potential for practical applicability. These results show that LLM-based intelligent user interfaces can meaningfully support healthcare professionals in complex care settings such as palliative care. These findings are particularly relevant in light of recent evidence highlighting persistent language barriers, cultural misunderstandings, and unmet needs in palliative care for patients from diverse cultural and migration backgrounds [13]. Consistent with prior findings on voice-based interaction [14], our results highlight both usability benefits and the importance of transparency and user confidence, as reflected in positive usability scores and reported user confidence during interaction. However, this work also has limitations that inform directions for future research. The evaluation was not conducted with clinical end users, and the findings therefore reflect usability assessments rather than real-world clinical effectiveness. Consistent with a prior systematic review highlighting a gap between technical capabilities and empirical validation of systems [15], technical sophistication alone does not ensure real-world adoption. Accordingly, future research should include in-situ studies with palliative care professionals to assess the system's impact on clinical workflows, care quality, and user acceptance. Building on ethnographic findings that emphasize the role of everyday practices and caregiver involvement in care technologies [16], such studies should specifically examine how intelligent assistants integrate into real clinical routines. From a technical perspective, future iterations could incorporate more powerful language models and improved speech-processing components, as well as further explore personalization, multilingual support, and deeper integration with existing clinical information systems to enhance relevance and scalability in everyday palliative care practice.

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Declaration on Generative AI

The authors used GPT-4 (OpenAI) for figure 1 in order to: Generate image. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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