Explore the possibilities of ChatGPT for ICU digital diary in the context of ICU

Master Thesis
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Abstract

ICU survivors have been shown to face memory loss during and after their ICU stays, which contributes the psychological issues. ICU digital diary has been proven as a way of filling the memory gap, thus avoiding the development of these mental issues. EMC has currently been working on the implementation of the digital diary and a tailored strategy should be considered to support ICU nurses in using the digital diary.

As ChatGPT's potential in the field of the ICU, this project starts with the assignment to explore the possibilities of ChatGPT for ICU digital diary in the context of the ICU. Leveraging a multidisciplinary approach, the project amalgamates insights from nurse practices, interface design, and the ChatGPT technology. Drawing on meticulous literature review, direct observations, and interviews, the results highlighted nurses' need for patient information visualisation and guidance in their diary writing, and the possible application that ChatGPT could provide in the digital diary. Based on the insights from research activities, a web application - Patient Diary Toolkit - was designed and developed through three rounds of design iterations. There are basically four main functionalities in this design: reviewing the patient diary, adding messages, diary tracker and ChatGPT-based assistant supporting nurses' diary writing.

This design was evaluated with 15 participants and 5 experts through comparative testing and expert interviews, with the aim of getting insights from their perspectives about the usability, the user experience and the future potential of the design. The results show that the interface is intuitive and easy to understand, and the introduction of the ChatGPT-based assistant offers a practical solution for supporting nurses' diary writing. Future recommendations including further research, optimisation of the functionality, future-focused solutions and user experience improvement have been discussed.

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Abbreviations

Artificial Intelligence - AI
Critical Alarms Lab - CAL
Erasmus Medical Centre - EMC
Intensive Care Unit - ICU
Large language model - LLM
Post-traumatic Stress Disorder - PTSD
Post Intensive Care Syndrome - PICS
Post Intensive Care Syndrome-Family - PICS-F

01 Introduction

This chapter aims to introduce the project background, research question, and project approach. Thsi section is where this graduation project begins.

Introduction

1.1 Project Background

Each year, over 30,000 patients are admitted to EMC and they stay in ICU for an average of 6 to 7 days (Erasmus, 2021). Advances in critical care medicine have allowed ICU patients to save their lives, but various problems remain in improving their long-term prognosis (Inoue et al., 2019). ICU survivors have been shown to face common psychological issues during recovery, including anxiety, depression and PTSD (Jones et al., 2010) and studies have shown that more than half of patients develop new physical, mental and/or cognitive problems after ICU stays (Geense et al., 2021), which are collectively called PICS.

Research is found that using ICU diaries in the ICU has many benefits for all stakeholders involved in the ICU. ICU diaries can help patients to understand what is happening during their ICU stay and the recovery process, thus avoiding the development of psychological problems (Brandao Barreto et al., 2021). Through the relevant studies, it has been shown that the ICU diary could reduce patients' anxiety and depression (McIlroy et al., 2019). For healthcare professionals from hospitals, reading ICU diaries and interacting with patients can help them improve the quality of patient daily care in a mental way (Haakma et al., 2022). Currently, Erasmus MC is working on the implementation of the Post-ICU, which is a digital version of the journal to provide personal information to ICU patients and their families. The research suggests that a tailored strategy should be considered to support ICU nurses in using Post-ICU since there are still some barriers for nurses in using Post-ICU.

With the rapid growth of AI, virtual assistants have begun to rule various industries. It is a computer program that engages the user in text messages within the website or application. This technique is now widely used in analyzing symptoms, managing medications, and even monitoring chronic diseases (LIGS University, 2021). AI assistants can increase the communication between patients-nurses and relative-nurses (Laranjo at el., 2018). Such technology proves to be cost-effective and can decrease the gap between health and well-being. Recent technological advances have made large language models a key factor in the development of conversational assistants. These models are trained to process large amounts of data and drive the shift from conversational AI to human-like experiences. OpenAI has recently released GPT4 which can accurately and fluently perform various natural language processing tasks and generate human-like text (OpenAI, 2023). How this technology can be adopted to help healthcare professionals in ICU still need to be explored further in the future.

Therefore, the possibilities of AI technology in combination with the Post-ICU, products and/or systems will be explored. An AI solution could be created to support ICU nurses in using Post-ICU. The main target group will be ICU nurses and the currently identified stakeholders in this project are ICU patients, Families of ICU patients and the hospital.

This project works with the ICU of EMC in Rotterdam, which can be helpful to get a better understanding of the context of ICU and the current situation of Post-ICU, thus bringing possibilities and design opportunities to conduct research with the target group, provide an AI-based solution, and evaluate the usability of the solution. This project also cooperates with CAL which

already has relevant studies exploring AI technology in the context of ICU, such as using AI to diagnose patients' stress and using AI for the humanisation of the ICU (Du, 2021). Based on these studies the possibilities of AI in the Post-ICU will be explored more profoundly in this project.

Figure 1: ICU environment in Erasmus MC

1.2 Research Question

The main research question of this project is formulated at the beginning of the project:

"What possibilities are there to apply the ChatGPT into the current Post-ICU thus supporting ICU nurses in using Post-ICU?"

This research question will be further refined as the research progresses and eventually answered.

1.3 Project Approach

In order to answer the main research question, the following design approaches were used throughout the project. An overview of the design process is shown in **Figure 2** and the design approach was explained as followed.

Context Research

The context research relies on literature reviews and some results from previous graduate students at CAL to gain an overview of PICS and the current situation of Post-ICU in Erasmus, which help us gain an overview of the context of the project.

User Research

In the stage of user research, the main research question was further refined and investigated by literature review, observation and semi-structured interviews with ICU nurses in EMC. The refined research question is as followed:

How to support ICU nurses in using Post-ICU?

The 2 sub-questions are:
- What information of patients do they interact with?
- What are the challenges and needs for nurses in the documentation of the diary?

A nurse's journey was mapped based on the observation to figure out the information they might interact with patients and relatives, and their needs for using Post-ICU were concluded based on the literature reviews and semi-structured interviews. In this case, the design opportunities and the design goal were formulated.

ICU diary research

In this chapter, the current physical ICU diary used in Erasmus was analysed and then key findings about the ICU diary were discussed, which can give some inspiration for the integration of Post-ICU in the current nurse's workflow in the further step.

ChatGPT inspirations&opportunities

In this part, the current application of ChatGPT in the healthcare field was investigated and then the potential application of ChatGPT in the context of ICU diary was discussed to support the main research question so that it can help the project to figure out the AI solutions for current Post-ICU to enhance the nurse's experience on using Post-ICU.

Concept Development

After forming the design brief, three possible design concepts were formed and the ChatGPT-based assistant were created in the Python. In the iterations section, there were basically two parts to be iterated: interfaces and ChatGPT-based assistant. In the iteration of interfaces, the fundamental usability and the efficiency were considered in the design. While in the iteration of ChatGPT-based assistant, a chatbot was developed to iterate the prompt based on the functions and the corresponding prompt templates were created to help nurse get start to use the ChatGPT-based assistant.

Evaluate the design

The final design - Patient Diary Toolkit - was designed and developed. This design was evaluated through user testing and expert interviews, gathering feedback on the usability and the experience of the design. Design improvements and future recommendations were discussed which may be helpful for the later projects.

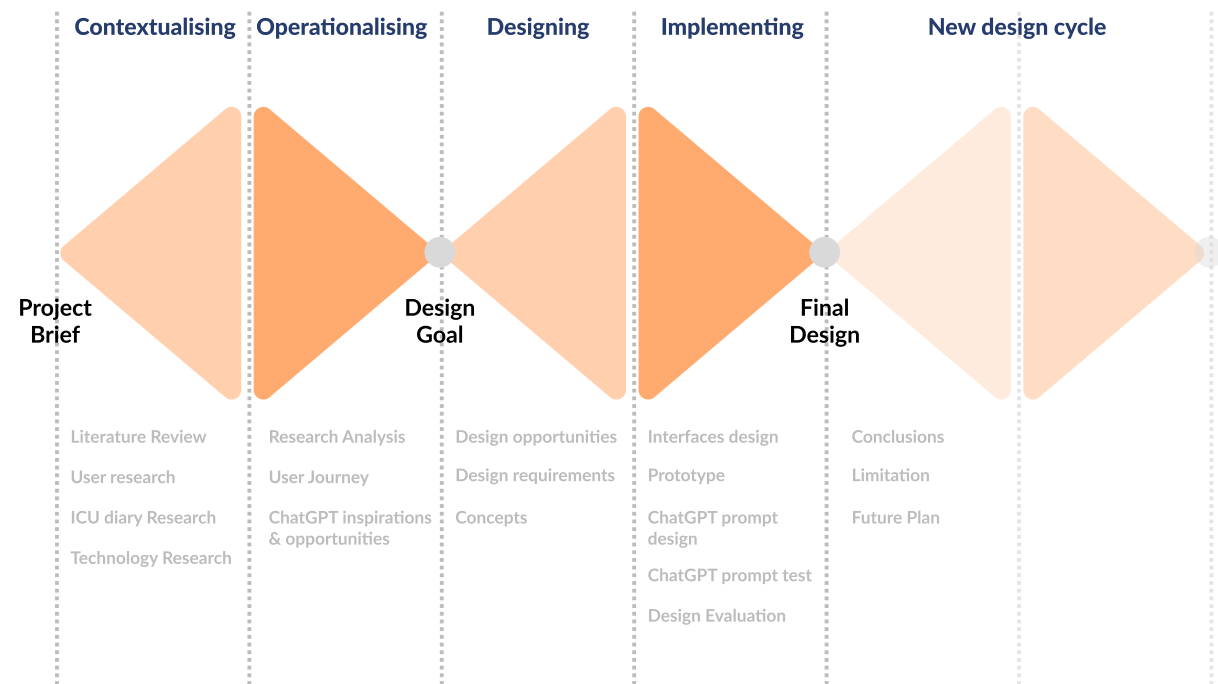| Contextualising	Operationalising	Designing	Implementing	New design cycle
Project Brief	Design Goal		Final Design	
Literature Review	Research Analysis	Design opportunities	Interfaces design	Conclusions
User research	User Journey	Design requirements	Prototype	Limitation
ICU diary Research	ChatGPT inspirations & opportunities	Concepts	ChatGPT prompt design	Future Plan
Technology Research			ChatGPT prompt test	
			Design Evaluation	

Figure 2: Project Approach

02 Context Research

In this chapter, the context of PICS and Post-ICU diary will be investigated. Based on the literature review, key findings was concluded to gain an overview of digital diary in the context of ICU.

Context Research

2.1 PICS

PICS is the collective manifestation of physical impairment, cognitive impairment and mental health problems that usually occur during or after the patient's ICU stay (Nakanishi et al., 2021). Studies have shown that more than half of patients develop new physical, emotional and cognitive symptoms after ICU stays (Geense et al., 2021).

Nowadays, healthcare professionals have shifted their attention to the long-term outcomes of ICU survivors of critical illness. What they discovered is that although the patient recovered, patients did not return to their former level of function for weeks, months and even years. Patients developed anxiety, depression, and PTSD, which are known as emotional symptoms and are related to their critical illness and their experiences during the ICU stays and/or after hospital discharge. Critical illness also affects the mental health of the patient's family, which is termed PICS-F (Nakanishi et al., 2021).

Although the technological development of the ICU is significant, there is still room for improvement in the humanistic aspects of care in the ICU. Humanity is a new trend in recent years (Du, 2021). Patients don't want only to survive from critical illness, they are also eager for humanity such as better communication, emotional support and the family's involvement in the care process. Except for medical support, nurses and relatives are the main stakeholders to provide emotional support for patients.
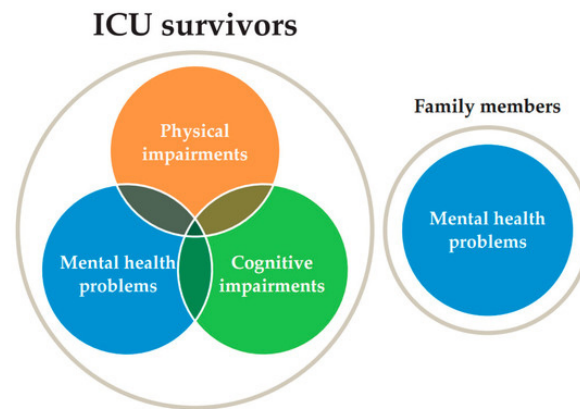

Figure 3: PICS & PICS-F (Nakanishi et al., 2021)

2.2 Post-ICU Diary

Memory loss for the time during ICU stay and the high proportion of non-quotable memories are associated with the development of anxiety, depression and PTSD (Nakanishi et al., 2021). They make it difficult for patients to make sense of what has happened to them and how did they recover from critical illness (Jones et al., 2000). These memories are frequently described by patients as frightening, and vague and may even involve patient's negative thoughts that nurses tried to kill them (Jones et al., 2010).

The use of ICU diaries started as a tool to fill the memory gaps and has been proven as a tool to help patients' memory and decrease the effects of emotional symptoms of PICS. The diary is written in everyday language and contains daily entries on the current patient status and descriptions of situations and surroundings in which the patient might find recognition. It is written by nurses and relatives and it is written directly to patients so that they can read the diary afterwards to know about their situation in ICU and their recovery process.

ICU diaries have been used regularly in various hospitals in international settings. In the Netherlands, there are about 87% of ICUs provided diaries and mostly they were written by relatives (Hendriks et al., 2019). In recent years, Post-ICU, an innovative digital ICU diary, was developed and implemented in some Dutch hospitals during COVID-19. Upon an invitation from the patient's relatives, nurses could write short messages in the patient's ICU diary. They are allowed to write not only their regular activities but also share their feelings on the circumstances of the patient. Before implementing Post-ICU at EMC, there were some strategies to support the implementation and a study was conducted to explore the experiences of ICU nurses with the implementation strategies and the applicability of the Post-ICU diary (Haakma et al., 2022). It suggests that nurses still experienced some barriers to writing the diary and a solution should be considered to support nurses in using the Post-ICU.
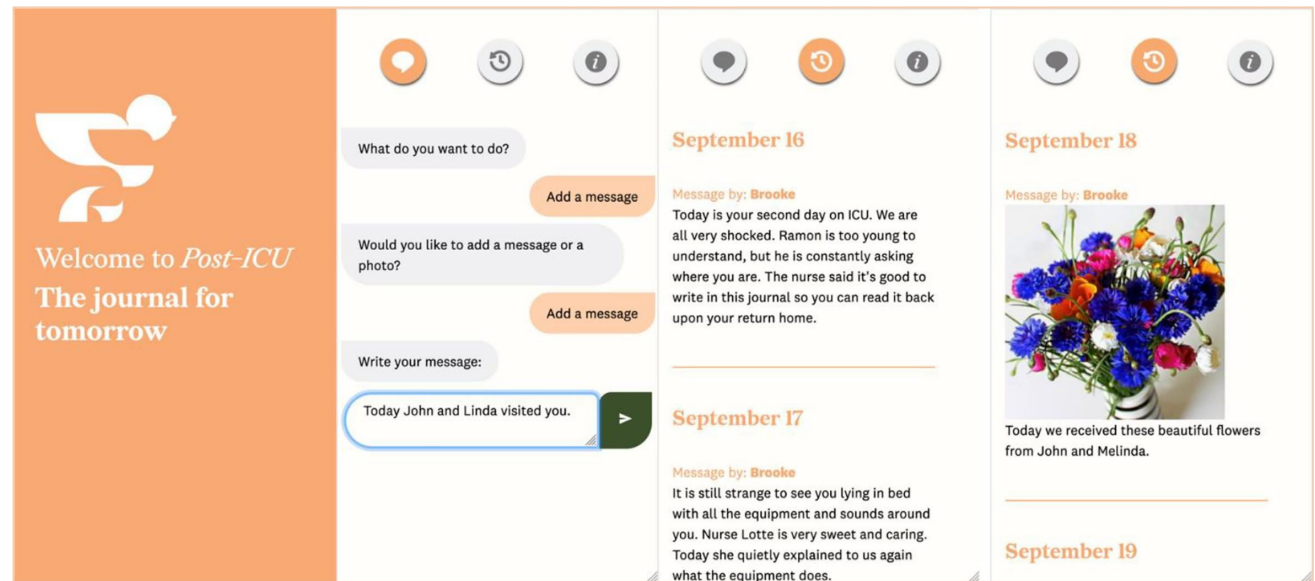

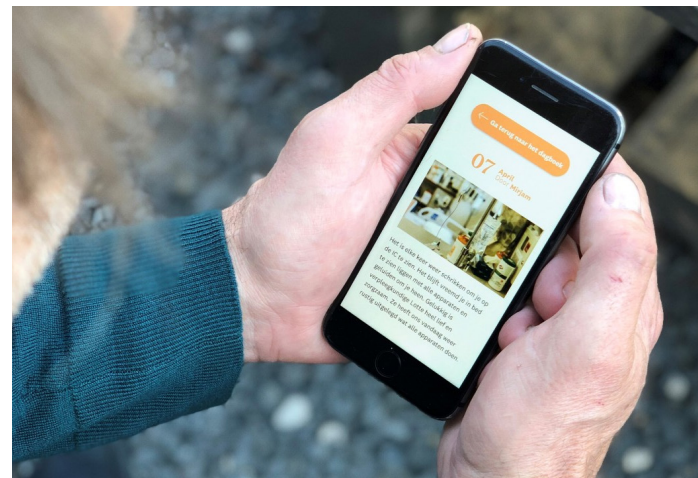Figure 4: The overview of screen layout about Post-ICU Diary (Haakma et al., 2022)

Figure 5: Reading the Post-ICU diary

2.3 Findings

More attention on the patient's emotional health in ICU

ICU survivors suffer emotional issues regarding their critical illness and experiences during ICU stays and discharge. Emotional issues could affect the quality of a patient's life for a long time. With the development of humanized care in the ICU, healthcare staff are paying more attention to the patient's mental health. They could provide not only medical support but also emotional support for patients.

The risk of emotional health problems is the stressful experiences for patients during ICU stays

Most patients suffer from memory loss and non-quotable memories, which might make them hard to understand the whole process from admission to discharge and lead to negative thinking about their ICU stays. Therefore, It is of vital importance for ICU survivors to construct a complete and accurate narrative of their ICU experiences thus reducing the risk of emotional health problems.

Support ICU nurses in using Post-ICU diary

In EMC, mostly the diaries were written by relatives, which means most nurses do not have much experience in using the diary, and there are still some barriers for nurses to write the diary before the implementation of the Post-ICU diary. It is considered to think about how to support ICU nurses in using Post-ICU.

2.4 Summary

To sum up, stressful experiences during the ICU stay affect the mental health of ICU survivors. ICU diaries have been proven to be a scientific tool to help patients fill the memory gap and construct a complete ICU narrative, thus decreasing the negative effects of mental health problems. Nurses provide not only medical support but also emotional support. Currently, EMC is working on the implementation of Post-ICU diary and an approach is needed to support nurses in using Post-ICU. Therefore, how to support ICU nurses in using Post-ICU diary will be the main research question in the user research.

03 User Research

This chapter investigated the patient ICU journey, the relevant information that should be written in the diary, and the current workflow of ICU nurses. For this, literature review, observation and interview were conducted, identifying and analysing the patient-related information that nurses interact with in their working day and their challenges on document these information, for which design insights are initially formed.

User Research: ICU Nurses

3.1 Background

In the previous chapter, the context of PICS and Post-ICU diary are studied. An approach to support ICU nurses in using Post-ICU is needed. However, how to support them in using Post-ICU remains unknown. Thus, in this chapter, user research is conducted to gain the users' needs and challenges, the design opportunities and the design goal. To get more insights about nurses' needs and challenges in their workflow, observation and semi-structured interviews were conducted with ICU nurses at EMC.

Research questions

During this phase of the project, the main research question is formulated as follows:

How to support ICU nurses in using Post-ICU diary?

To answer the main question, it needs to be clear what information about patients nurses interact with and what content can ICU nurses provide in the patient diary. How nurses expect to use the diary and their challenges and needs/expectations in the Post-ICU also need to be figured out in this phase.

Therefore, two sub-questions were formulated:

- What information of patients do nurses interact with during a working day? What information can they provide in the diary based on the nurse's workflow?
- How will ICU nurses document the diary? What are their needs and challenges in the documentation of the diary?

3.2 Methods

Literature Review

The patient's ICU narratives are constructed in the ICU diary from healthcare professionals' perspectives and relatives' perspectives. Therefore, it is of vital importance to investigate the patient's ICU experience first, which information is necessary to document and recommendations on how to construct patient's ICU narratives from nurse's perspectives. Therefore, patients' ICU experiences in the ICU, their perceptions of the ICU diary and recommendations on the diary were studied through the literature review. And the subjects of diary entries were also concluded based on the literature review.

For the results from the observation, the literature review was also used to define the nursing activities that are closely relevant to patients and relatives (Han et al., 2020), and to categorised the information nurses could provide in the diary in the nurses' journey (Egerod & Bagger, 2010).

Since the ICU diary has not been implemented into the current nurse system and most nurses have no experience with the Post-ICU diary in Erasmus, it is feasible to research nurses' general needs by literature review and interview. Erasmus has studied the implementation of Post-ICU in Erasmus, which gives us insights into the nurse's experience in using Post-ICU.

Observation

To gain a general knowledge of the ICU environment and then answer sub-question 1, observation was conducted. To obtain in-depth knowledge of nurses' workflow, and the information nurses interact with and provide in the diary, a nurse's journey for morning shift and afternoon shift was mapped. Firstly, the researcher sit in the observation unit and observed the nurse's

activities during the morning shift and evening shift. During the observation, the researcher notes the nurses' daily tasks not only about medical support but also emotional support including communications with patients and relatives. Then the researcher started a short discussion with some nurses to gain more details about the nurse's workflow. After the discussion, the researcher was given a quick tour of the patient and the current ICU diary they offered to relatives was introduced to the researcher.

Semi-structured interview

To answer the sub-question 2 as mentioned in the previous chapter, a semi-structured interview was conducted with 5 ICU nurses from EMC. Their profiles are described in **Table 1**. A list of questions was prepared in advance and the questions were shown in **Table 2**. Firstly, a brief introduction about the project was explained. Then, the researcher conducted one-to-one interviews with ICU nurses. Each section was about 10-15 minutes.

Gender	Nurse experience	Diary experience	Shift
Female	> 8 years	No	Morning shift, Afternoon shift
Male	15 years	No	Morning shift, afternoon shift
Female	>7 years	No	Morning shift
Female	>7 years	No	Morning shift, afternoon shift
Male	>9 years	No	Morning shift

Table 1: Participant Profile

Main themes
1. Can you share your thoughts about the current ICU diary?
2. What are the difficulties when communicating with relatives to discuss the patient's situation? Is the diary mentioned in the conversation?
3. Who should be able to write in the diary?
4. If you are involved in the process of using the ICU diary, how would you think and what would you expect?
5. What are the difficulties do you think if you are involved in the process of using diary?
6. Do you have any suggestions for improvement of diaries?

Table 2: A List of Questions

3.3 Results & Key findings

Literature review, observation and semi-structured interview have provided insights into the working context of ICU nurses at EMC. The research has resulted in one timeline of nurses' morning shifts and evening shifts with corresponding experiences and insights, and recommendations on constructing patients' ICU narratives. Both results led to design opportunities.

Recommendations on Constructing Patient's ICU Narratives

The insights from the literature review are shown in this chapter. The timeline of patients' ICU narratives and essential information for different phases are concluded in **Figure 5**. The patient's ICU narratives were constructed as the patient's ICU story from admission to discharge (Egerod et al., 2011). There are four important points and three phases in the ICU narratives. It is of vital importance to write the situation of these four important points and the subjects in each phase are recommended to be written in the diary (Maagaard & Laerkner, 2022). Some subjects could be written by both relatives and nurses while some subjects could only be provided by relatives regarding the

personal information of patients or family visits in the hospitals.

Based on the patient's ICU narratives, the nurse's experience and the recommendations, the information provided by ICU nurses could be classified into four parts and each part has support contents, which could help nurse to know what to write in the diary, which is shown in **Figure 6**.
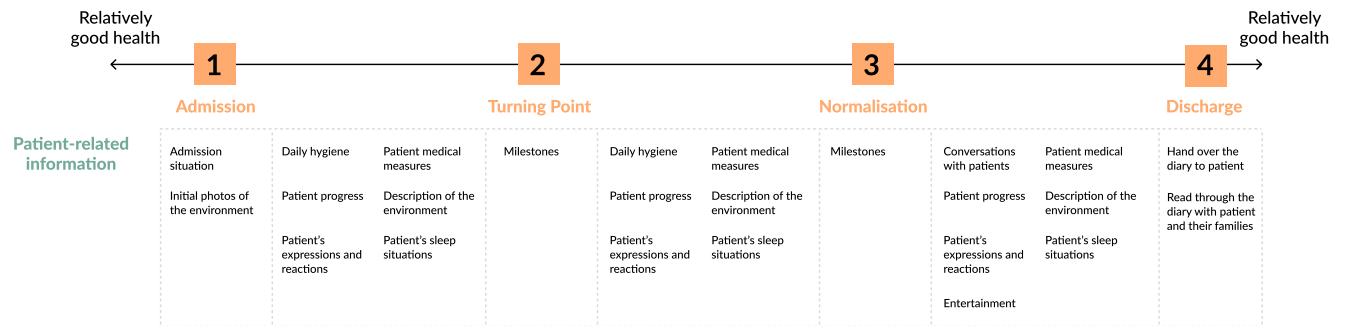

Relatively good health

Relatively good health

	1 Admission	2 Turning Point	3 Normalisation	4 Discharge
Patient-related information	Admission situation	Milestones	Milestones	Hand over the diary to patient
	Initial photos of the environment	Daily hygiene	Conversations with patients	Read through the diary with patient and their families
	Daily hygiene	Patient progress	Patient progress	
	Patient progress	Patient's expressions and reactions	Patient's expressions and reactions	
	Patient's expressions and reactions	Patient medical measures	Entertainment	
	Patient medical measures	Description of the environment	Patient medical measures	
	Description of the environment	Patient's sleep situations	Description of the environment	
	Patient's sleep situations		Patient's sleep situations	

Figure 5: Patient's ICU journey & Patient-related information

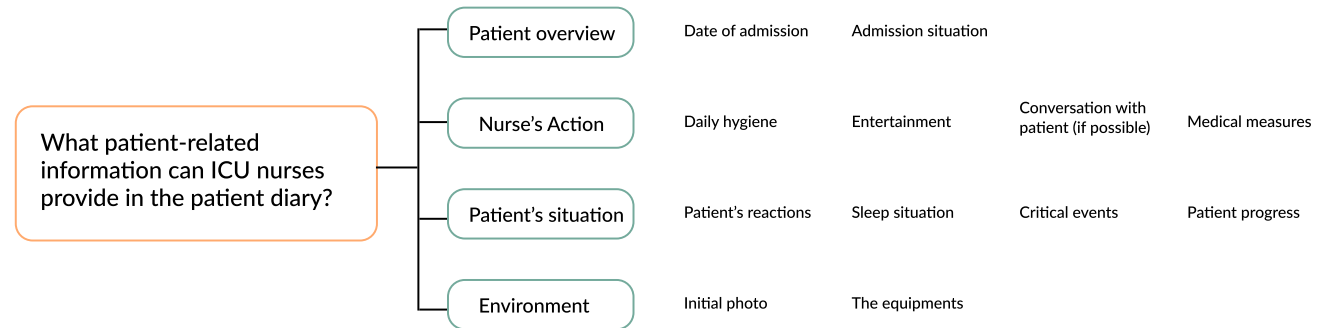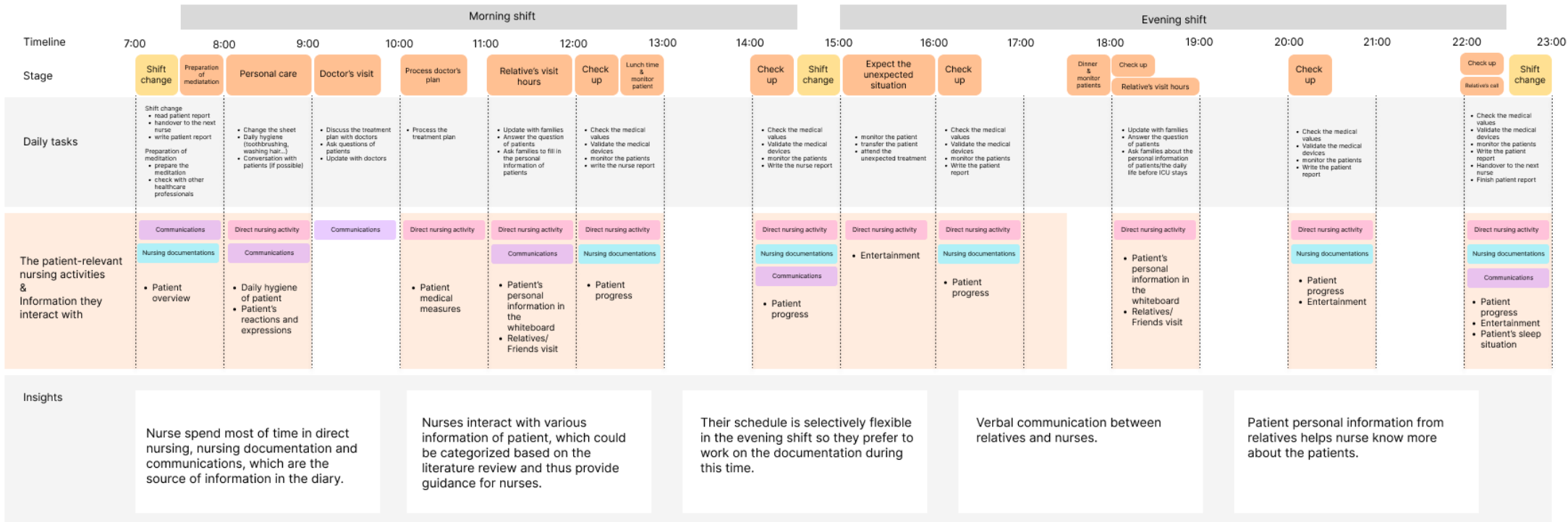| What patient-related information can ICU nurses provide in the patient diary?	Patient overview	Date of admission	Admission situation		
	Nurse's Action	Daily hygiene	Entertainment	Conversation with patient (if possible)	Medical measures
	Patient's situation	Patient's reactions	Sleep situation	Critical events	Patient progress
	Environment	Initial photo	The equipments		

Figure 6: Patient-related information that ICU nurse could provide in the patient diary

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Nurse's Journey during morning shift and afternoon shift

Timeline

	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00

Morning shift | **Evening shift**

Stage
- Shift change
- Preparation of mediation
- Personal care
- Doctor's visit
- Process doctor's plan
- Relative's visit hours
- Check up
- Lunch time & monitor patient
- Check up
- Shift change
- Expect the unexpected situation
- Check up
- Dinner & monitor patients
- Check up
- Relative's visit hours
- Check up
- Check up
- Relative's call
- Shift change

Daily tasks

Shift change
- read patient report
- handover to the next nurse
- write patient report
Preparation of mediation
- prepare the mediation
- check with other healthcare professionals

- Change the sheet
- Daily hygiene (toothbrushing, washing hair...)
- Conversation with patients (if possible)

- Discuss the treatment plan with doctors
- Ask questions of patients
- Update with doctors

- Process the treatment plan

- Update with families
- Answer the question of patients
- Ask families to fill in the personal information of patients

- Check the medical values
- Validate the medical devices
- monitor the patients
- write the nurse report

- Check the medical values
- Validate the medical devices
- monitor the patients
- Write the nurse report

- monitor the patient
- transfer the patient
- attend the unexpected treatment

- Check the medical values
- Validate the medical devices
- monitor the patients
- Write the patient report

- Update with families
- Answer the question of patients
- Ask families about the personal information of patients/the daily life before ICU stays

- Check the medical values
- Validate the medical devices
- monitor the patients
- Write the patient report

- Check the medical values
- Validate the medical devices
- monitor the patients
- Write the patient report
- Handover to the next nurse
- Finish patient report

The patient-relevant nursing activities & Information they interact with

- Communications
- Nursing documentations
  - Patient overview
- Direct nursing activity
- Communications
  - Daily hygiene of patient
  - Patient's reactions and expressions
- Communications
- Direct nursing activity
  - Patient medical measures
- Direct nursing activity
- Communications
  - Patient's personal information in the whiteboard
  - Relatives/ Friends visit
- Direct nursing activity
- Nursing documentations
  - Patient progress
- Direct nursing activity
- Nursing documentations
- Communications
  - Patient progress
- Direct nursing activity
  - Entertainment
- Direct nursing activity
- Nursing documentations
  - Patient progress
- Direct nursing activity
  - Patient's personal information in the whiteboard
  - Relatives/ Friends visit
- Direct nursing activity
- Nursing documentations
  - Patient progress
  - Entertainment
- Direct nursing activity
- Nursing documentations
- Communications
  - Patient progress
  - Entertainment
  - Patient's sleep situation

Insights

- Nurse spend most of time in direct nursing, nursing documentation and communications, which are the source of information in the diary.
- Nurses interact with various information of patient, which could be categorized based on the literature review and thus provide guidance for nurses.
- Their schedule is selectively flexible in the evening shift so they prefer to work on the documentation during this time.
- Verbal communication between relatives and nurses.
- Patient personal information from relatives helps nurse know more about the patients.

Nurse's Challenges & Needs on the diary

Challenges
- Lack confidence in writing messages
- Non-experience nurses do not know what to write exactly
- Most nurses do not exactly know how to write the entries except the medical actions
- Nurses worried about the entries might be difficult for patients/ relatives to understand

Needs
- Being confidence in writing entries
- To know what should be written in the diary from nurse perspectives
- Guide them on patient ICU narratives
- Explain the situation and progress of patients in a easy-to-understand way

Figure 7: Nurse's journey map & Design Insights

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3.4 Key findings

The insights from observations and interviews are mapped into one poster. **Figure 7** visualizes three parts in the overview, namely:

1. The patient-relevant nursing activities & information the nurse interacts with: This part highlights the nursing activities that are highly relevant to patients and lists the information the nurse interacts with, which is helpful to write in the diary thus constructing a more complete patient's ICU story.

2. Insights from observations and interviews: This part shows the insights gathered from the observation, which are a source for the design opportunities.

3. Nurse's Challenges & needs in the diary: The challenges for nurses are based on the literature review and interview and these are also a source for the design opportunities.

Four key points and three phases of patients' ICU narratives

ICU diaries are essential sources for patients to construct their ICU story. Constructing a more complete ICU narrative in the diary helps patients to fill the memory gap after discharge. However, the contents of the diaries are often shaped by the family's experience and preferences. The working process regarding the diary for ICU nurses needs detailed and scientific standardisation. It is recommended to describe four key points and three phases of patients' ICU narratives from the literature review. In the context of patients' ICU narratives, the content of the diary could be standardised based on evidence-based ICU narrative guidelines, thus helping bridge the span from admission to discharge.

Information nurses interact with during the Morning shift and Evening shift

From the nurse's journey, a nurse's schedule is partly structured and selectively flexible to face unexpected changes. Every nurse is responsible for 1-2 ICU patients. Nurses know exactly their tasks in different phases of a working day. During the morning shift, often, nurses are busy preparing medication, doing patients' personal care and processing doctor's visit. They also need to update patients' families and comfort them as well as possible by taking away as much unclarity as they can. Therefore, the patient's daily information has interacted with them and is helpful for diary writing. While during the evening shift, nurses are not necessarily busy but still working constantly in case of any unexpected situations. Nurses check upon patients' progress every 2 hours and do the validation if necessary. Apart from check-ups, nurses sit in the observation unit, mind the dashboard constantly and work on their documents such as personal notes and nurse reports. They can also communicate with colleagues to update patients' progress if the patients are in a stable state or meet patients' social needs such as playing music or turning on the TV.

Therefore, the information nurses interact with patients during these two shifts has some differences, which might lead to the different content of the diary. For example, nurses on the morning shift spend more time on medical care and it is feasible for them to

write short messages and describe patient's progress in the diary. Nurses on the evening shift have more time to observe patients and on social care. In this case, they can describe the patient's expressions/reactions or express their feelings when caring for patients.

Integration of ICU diary in the nurse's workflow

The nurse's workflow differs in these two shifts. It gives an overview of when the nurses do and how long they finish. Before the integration of the ICU diary, it is necessary to provide a personalised strategy for using the diary from the nurse's perspective, considering when to write the diary as well as how long they can write without interfering with their current workflow.

Providing guidance for nurses in using the diary

Most nurses do not have experience with the ICU diary and do not have clear directions about what to write and how to write exactly. They also find it difficult to explain some complicated patient situations in a short message and in an understandable way.

It can be considered to provide nurses guidance on the content and language style of the diary, thus helping them write the diary and transfer understandable messages through the diary.

04

ICU Diary Research

This chapter investigates the ICU diary that Erasmus are currently using and the Post-ICU diary. For this, key findings are concluded to give us some insights to generate the design brief.

ICU Diary Research: Post-ICU Diary

4.1 Background

Post-ICU is an innovative and supportive digital diary for clinical bedside nurses providing short messages to ICU patients and their families, thus, preventing or alleviating the PICS (Post-ICU, 2022). Studies have shown that journaling benefits ICU healthcare professionals as well. ICU nurses can change their daily care for the patients and families through the interactions and reading in the Post-ICU diary. Also, nurses can offer their perspectives on the often aspects of the recovery journey of patients, thus, constructing a more complete patient ICU story and filling patients' memory gaps.

More and more healthcare institutions have recognized the potential of the Post-ICU diary and have started incorporating it into the nurse's working process. Some hospitals encourage patients to maintain digital diaries with photos, videos and voice recordings. In the Netherlands, more and more hospitals are considering integrating Post-ICU diary into ICU nurses' workflow, thus, enhancing the human-centred ICU practice. Currently, the physical diary is still used in the EMC and nurses are not involved in the working process of the diary. EMC is working on the implementation of the Post-ICU diary and

there are still some barriers for nurses to solve before integrating Post-ICU diary into the current ICU nurse's workflow.

4.2 Research

Intensive Care Diary

Currently, Intensive Care Diary in physically is still used in EMC. It mainly consists of four parts: a booklet, a notebook, instructions in ICU, and some introductions about PICS and support from hospitals. These five parts were shown in **Figure 8-11**.
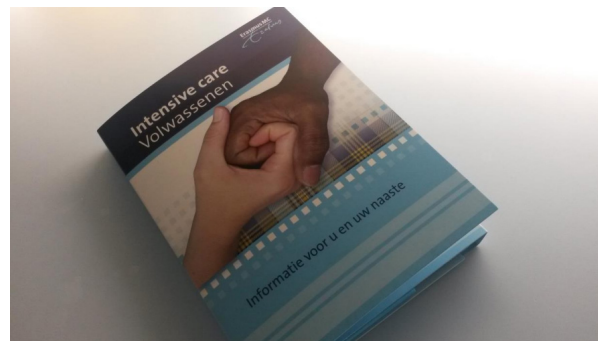
Figure 8: Overview of the Diary

1. Booklet
This booklet contains advice and information about the ICU. It gives an overview of things the patients and their families might face when patients are admitted to the ICU, what might happen in the recovery process and how patients and families could respond to some uncertain situations during severe illness and ICU stay.
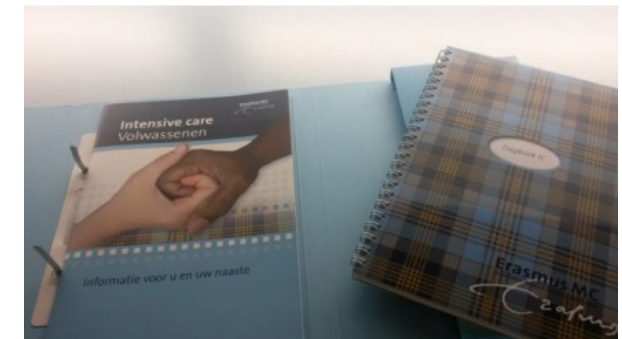
Figure 9: The booklet in the diary

2. Notebook
Families could use the notebook to write everything down during the whole ICU stay. They could write it in the ICU or at home. According to the nurses from EMC, the family is not going to initiate a conversation with the nurse about what is in the diary.

Nurses are not authorized to read the diary unless the family has given their consent.
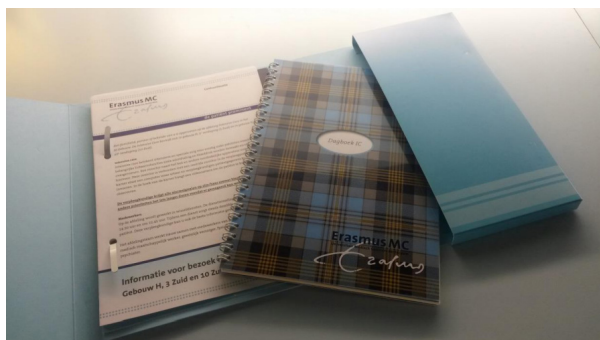
Figure 10: Notebook in the diary

3. Instruction in ICU
In this instruction, families can find information about the situation they need to face during the patient's ICU stay. It includes the time of the nurse's shift, family visit hours and contact details between families and nurses if families want to visit patients or know more information about patients via phone. It also introduces some ICU steps to help families gain an overview of the process of intensive care.
4. Introductions about PICS
These introductions are included medical social work, mental care, delusion, and freedom-restricting interventions (VBI), which could help patients and families know about some symptoms of PICS and how to prevent or alleviate the PICS.
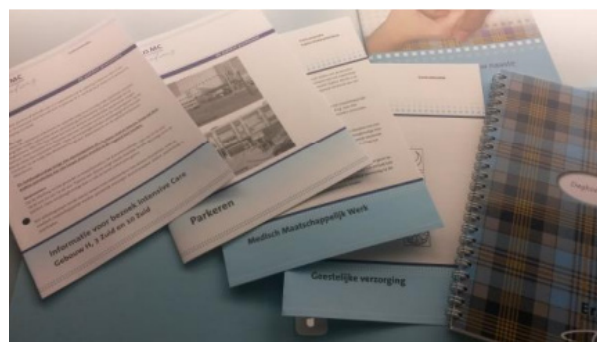
Figure 11: Instruction in ICU & Instructions about PICS

Post-ICU Diary

Post-ICU Diary was made available on any connected device with a display (e.g., smartphone, tablet, monitor). ICU Nurses could contribute short messages similar to WhatsApp functionality or write longer stories about what happened in the personal situation of the patient. They could also read the diary entries from relatives and other healthcare professionals. These voluntary messages, which most nurses wrote in addition to their regular daily activities, could, be a valuable contribution to the relative's description of the situation and non-medical circumstances each day for the ICU patient.

Before using Post-ICU, nurses need to create an account to keep the journal secure. After entering their email address and password, nurses use a journal code from patients' families to open an existing journal and then they can start to write the diary entries. The process of logging in were shown in **Figure 14.**

The diary writing process is basically done in a set chatbot system. The chatbot follows a predefined conversational flow and provides predefined responses based on the option in user input. The interface of diary writing is shown in **Figure 15.** Nurses could choose whether to write or to request a suggestion about diary subjects. After choosing to write diary entry, chatbot allows them to input the diary entries in the dialogues, choosing the date of entry and adding it to the diary. In **Figure 15,** the process of diary-writing in the Post-ICU Diary were shown.

If nurses are confused about what to write, they could request a suggestion about diary suggestion. Chatbot will enquire whether the patient is conscious or non-conscious and provide suggestions based on the current situation of the patient. Aftering choosing the subjects, they can input a diary entry in the dialogues and add it to the patient's diary. The interface of diary subjects' suggestions is shown in **Figure 16**. The conversational flow of suggestions is shown in **Figure 12** and all predefined responses (diary subjects' suggestions) in two different patient's states are listed in **Figure 13**.

In addition to adding diary entries to the diary, nurses also have access to read the patient's diary. The interface of reading the diary is shown in **Figure 17**.

There is a filter function at the bottom of the interface. Nurses can set whether or not they want to read messages from certain types of users. For example, they may prefer not to read messages from nurses. What they set below is only for what they want to read themselves. Also, they can choose whether the messages are presented all details of diary entries or as a shortened list. And they can set which period they want to read. After finishing the setting, the system goes back to the interface of reading the diary.

The process of setting reading preferences is shown in **Figure 18**.

Conversational flow

Figure 12: Conversation flow of diary subject's suggestion
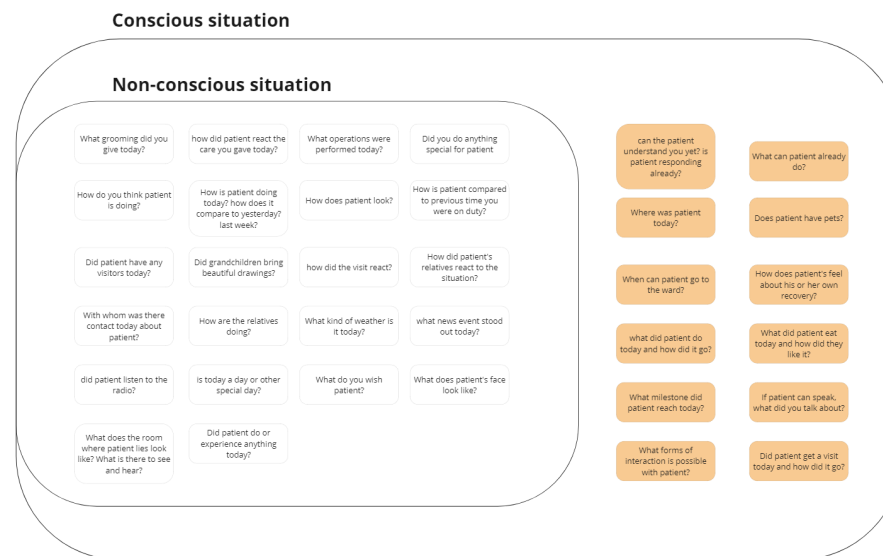
Figure 13: Suggestions for non-conscious patients and conscious patients
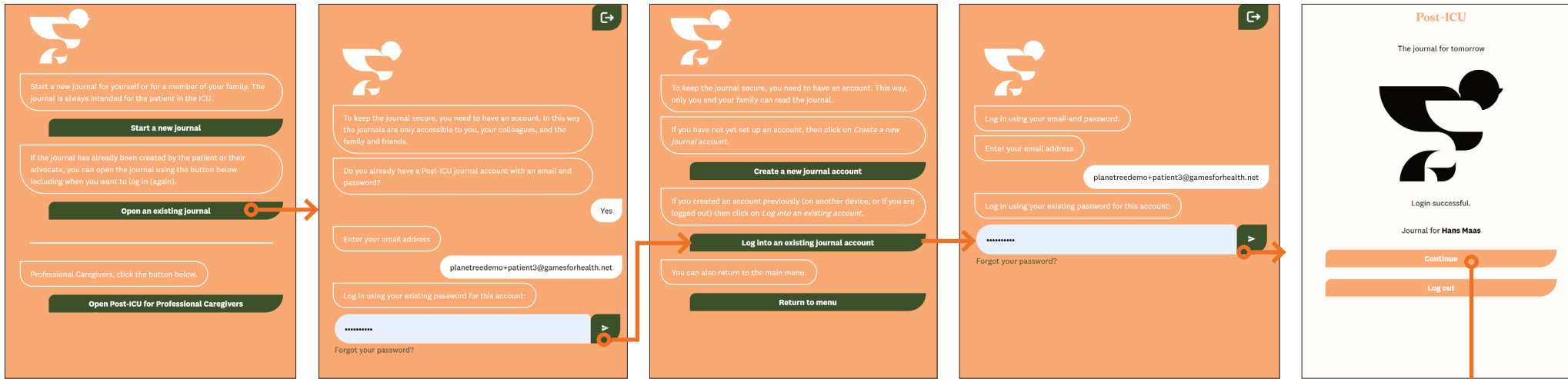
Figure 14: The process of logging in the Post-ICU Diary
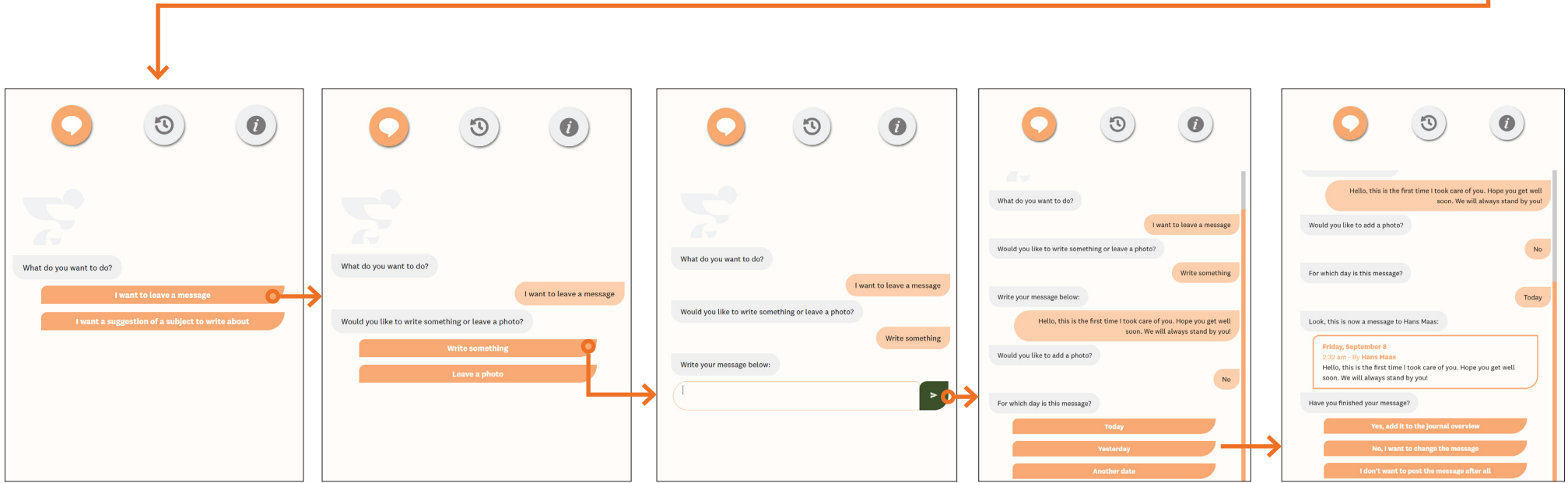
Figure 15: The process of diary writing
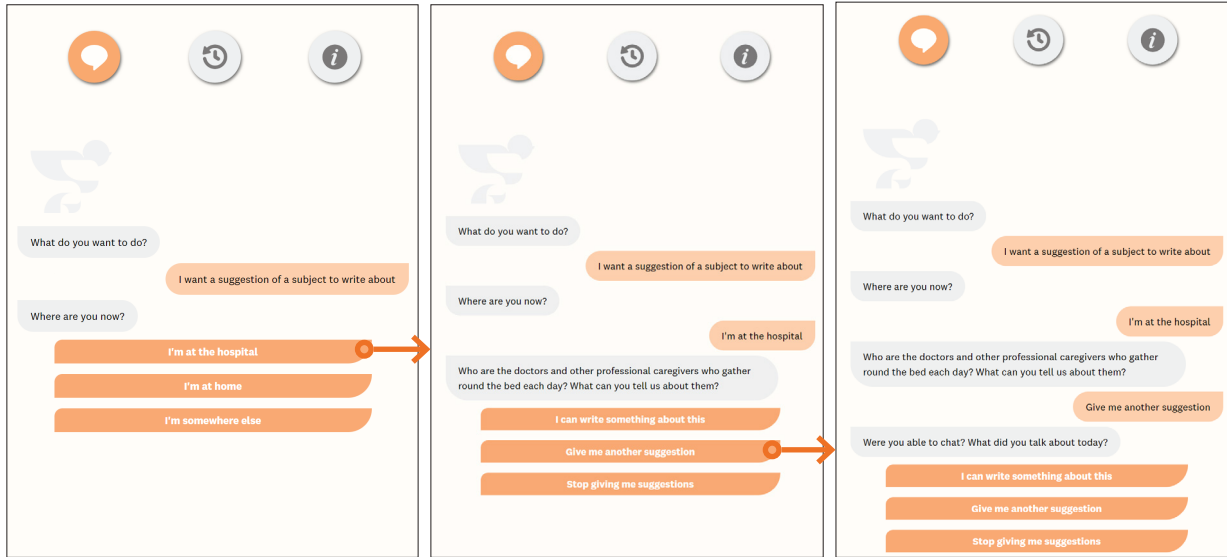
Figure 16: The interface of diary subject's suggestions
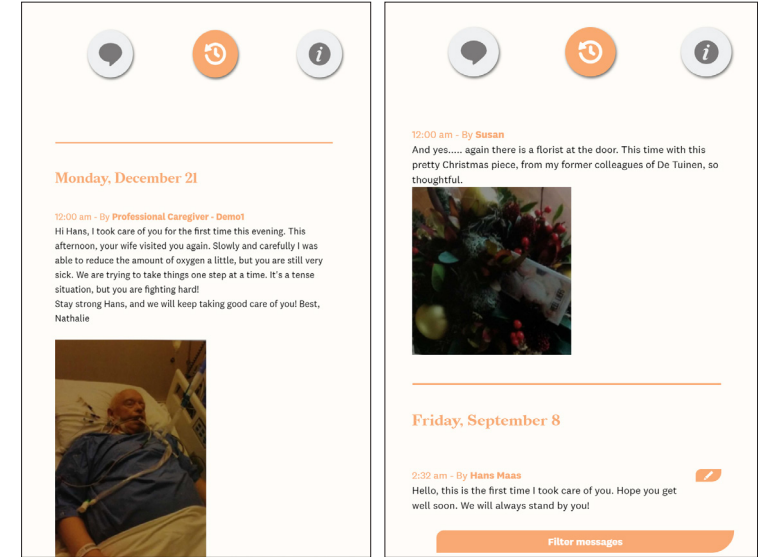
Figure 17: The interface of Reading the diary
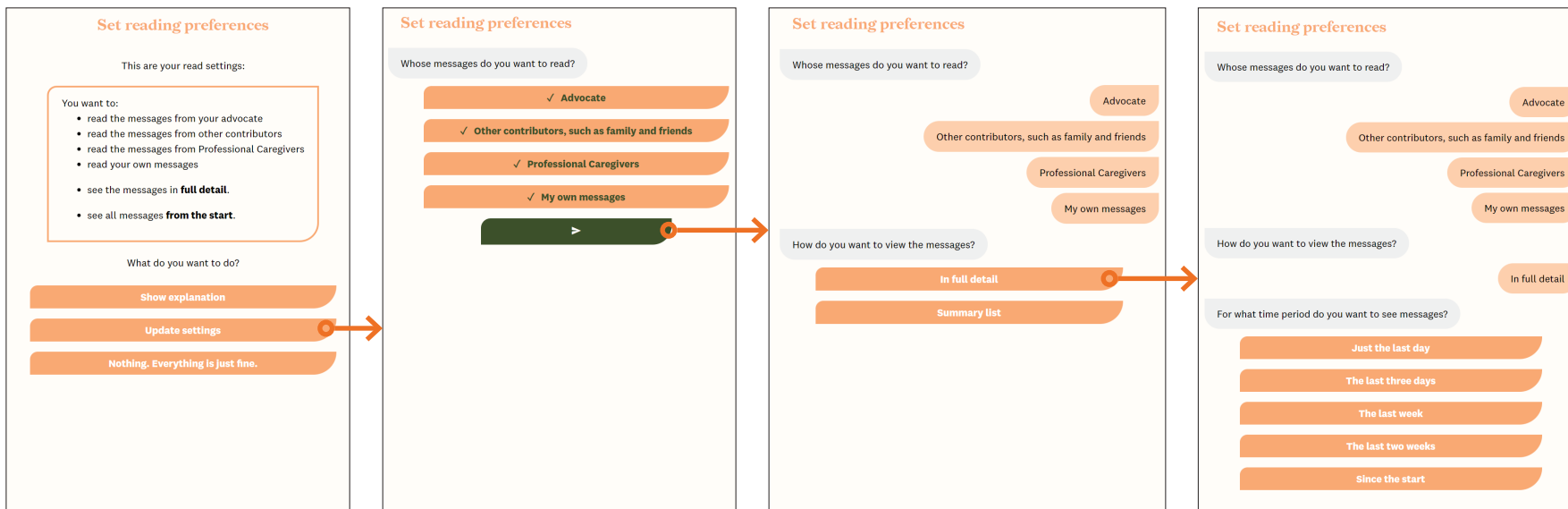
Figure 18: The process of setting reading preferences

4.3 Key findings

Low personalisation and inappropriate responses for the suggestion of diary subjects

The chatbot provides suggestions only based on the patient's situation and all the responses for the suggestion are predefined by developers, which have limited flexibility in responses. Furthermore, there are some overlapping suggestions for these different situations and some of the suggestions provided may not be necessarily useful for some patients, such as the suggestion "Did grandchildren bring beautiful drawings?" and "How did the visit react?", which may affect the applicability of the suggestions as well as taking more time to request the suggestions. The provided suggestions could be more personalised and appropriate, allowing nurses to write diary entries more efficiently and effectively.

Low efficiency and low flexibility of user interactions

The interactions between users and Post-ICU rely on predefined conversational flows and have a limited scope of the conversation. In this case, the flexibility of user interactions is limited. Users are only able to follow a specific set of steps and then receive predefined responses based on keywords or patterns in user input. If users want to add a diary entry, they need to go through at least four steps and each step is irreversible, which leads to low-efficiency user interaction.

05

ChatGPT Inspirations & Opportunities

This chapter introduces the Large Language Model and illustrate the working process of LLMs. Then ChatGPT - one of the LLMs and is popular in recent years - is introduced by illustrating the working principles, the ChatGPT API and ChatGPT prompt formula. And the technology research about ChatGPT's current application in ICU fields is conducted to give us the inspirations about how ChatGPT can contribute to the ICU digital diary.

ChatGPT Inspirations & Opportunities

5.1 Large Language Model

Large Language Models (LLMs) are a cutting-edge class of artificial intelligence models designed to understand, generate, and manipulate human language. These models are built upon advancements in deep learning, particularly the transformer architecture, which enables them to process and generate text with remarkable fluency and coherence. LLMs have gained substantial attention due to their impressive ability to perform a wide range of natural language processing tasks, such as text completion, language translation, text summarization, sentiment analysis, and more.

The operation of a Large Language Model involves two primary stages: pre-training and fine-tuning.

1. Pre-training: In this phase, the model is exposed to an extensive and diverse dataset containing a wide variety of text from different sources. During pre-training, the model learns to predict the next word in a sentence, capturing grammar, syntax, and contextual relationships. This process equips the model with a broad understanding of language.

2. Fine-tuning: After pre-training, the model is further trained on specific tasks using a more focused dataset. This process fine-tunes the model's knowledge for particular applications, making it adept at tasks like translation, summarization, or text completion. Fine-tuning customizes the model's behaviour for specific needs.
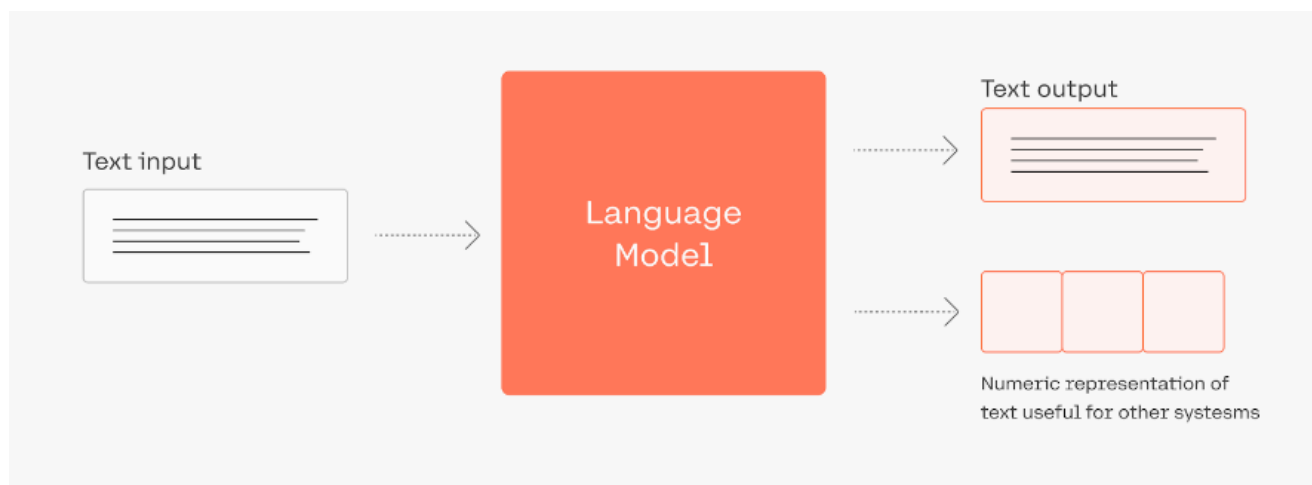
Figure 19: The principles of LLMs (Cohere, 2023)

5.2 ChatGPT

ChatGPT is a prominent example of a Large Language Model developed by OpenAI. It was trained using a variant of the GPT (Generative Pre-trained Transformer) architecture. ChatGPT is designed to engage in text-based conversations and generate contextually relevant responses. It combines the pre-training and fine-tuning process mentioned earlier to create a model that understands user inputs and generates coherent, contextually appropriate replies.

ChatGPT's architecture enables it to consider the conversation history and context, allowing it to generate responses that align with the ongoing conversation. This dynamic contextual understanding is what sets it apart from traditional chatbots that often produce generic or unrelated responses.

Large Language Models like ChatGPT find applications in content generation, customer support, language translation, creative writing, and more. Their ability to understand context and generate coherent responses has the potential to revolutionize how humans interact with AI, enhancing various industries and services. However, ethical considerations are paramount, as LLMs can inadvertently propagate biases present in their training data and raise concerns about misinformation and responsible AI deployment.

In essence, Large Language Models, exemplified by ChatGPT, represent a significant stride in AI-driven natural language processing, opening up new frontiers for human-machine communication and collaboration while emphasizing the need for responsible and thoughtful development and usage.
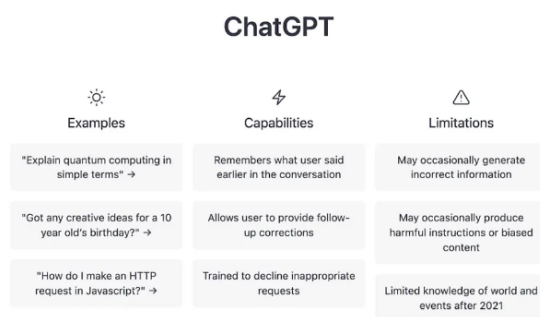
Figure 20: The interface of ChatGPT (OpenAI,2022)

ChatGPT API

ChatGPT API is a tool that allows users to integrate the power of ChatGPT into their own applications, products or services. It gives users access to ChatGPT's ability to generate human-like responses to questions and engage in the conversation. There are some implementation of the API such as some online shopping applications that make recommendations for shoppers based on their requests (Experts, 2023). In a word, developers are allowed to use the API to build applications using various programming languages that can generate text, hold intelligent and engaging conversations with end-users, and provide informative responses.
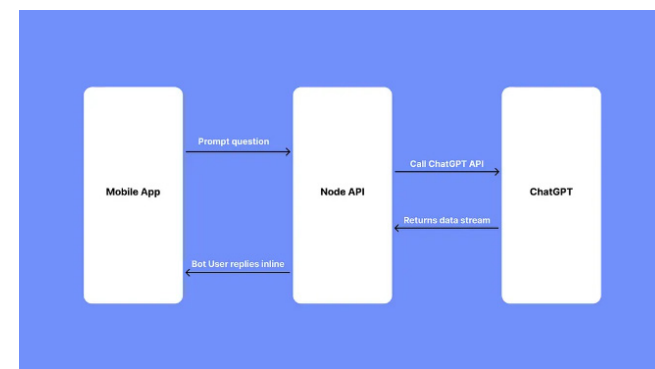
Figure 21: The process of calling ChatGPT API in the existing application (Kashyap, 2023)

ChatGPT Prompt

A ChatGPT prompt is an instruction or discussion topic a user provides for the ChatGPT AI model to respond to. The prompt can be a question, statement, or any other stimulus intended to spark creativity, reflectio, or engagement.

In the case of ChatGPT, there are still a lot of opportunity for both garbage in and garbage out because the outputs are limited by the input. Therefore, one of the key factors that determines the success of a ChatGPT conversation is the quality of the prompts that are used to initiate and guide the conversation (Eric, 2022). Well-defined prompts can help to ensure that the conversation stays on track and covers the topics of interest to the user. While a poorly defined prompt will lead to conversations that are lack focus, resulting in a less informative experience. To know the principles of designing a prompt and crafting effective prompts is of importance for effective and informative conversations with the ChatGPT system. There are some methods that could level up the ChatGPT prompt :

- Provide context: writing a prompt is more than just asking a one-sentence question. It often involves providing related background information to set the context of the query (Gewirtz, 2023).

- Give a clear, descriptive, and accurate task: users are allowed to break down bigger tasks into smaller ones and then ask the ChatGPT step-by-step, which makes prompt clearer (Cook, 2023).

- Include helpful information upfront: the AI is not too smart to know about the users.

Therefore, users can give it the information it needs, so it can reference it directly and give the output users expect (Robinson, 2023).

- Ask for ChatGPT: another effective strategy for creating powerful prompts is to have the AI do it for users. By asking GPT to craft the ideal prompt based on users' specific needs-and then reuse it on itself (Robinson, 2023). Writing prompt technique: there are some writing prompt technique that users need to focus on, such as avoid ambiguity, use natural language and avoid open-ended questions (Slater, 2023).
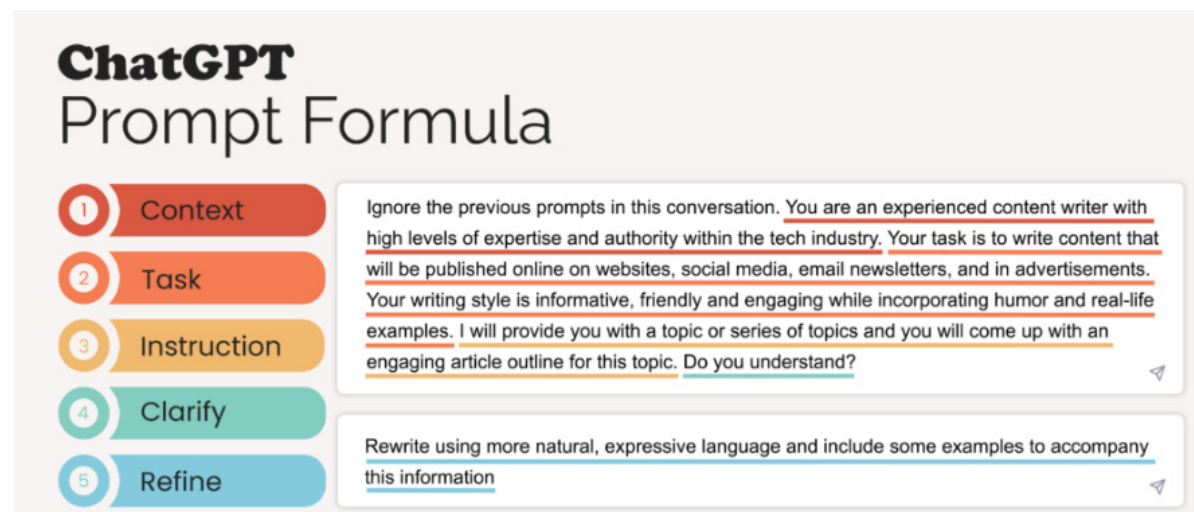
Figure 22: 5 key steps of ChatGPT Prompt formula (Assaraf, 2023)

In conclusion, writing better prompts for ChatGPT requires careful consideration of the language and information provided. By following some guidelines, users are able to optimise the AI model's performance and get the responses they expect.

5.3 ChatGPT in ICU field & Inspirations for ICU diary

ChatGPT is an AI-based chatbot developed using supervised and reinforcement learning strategies and it has become more and more popular since its launch in December 2022. Initially, ChatGPT was fine-tuned from a model in the GPT-3.5 series. As it has gained more attention recently, the OpenAI company has quickly launched the advanced version of this large language model, GPT-4. Compared with GPT-3.5, GPT-4 is a newer multimodal system that accepts various types of input and output including text and images with increased accuracy (OpenAI, 2022).

Compared with chatbots, ChatGPT has advantages:

- Its potential to comprehend and generate human-like texts
- Can be employed for a wide range of tasks like language translation, text summarization, language generation, natural language processing, and writing messages based on the prompt
- Scalable and open to fine-tuning

Although there remains a lack of studies summarizing the potential of ChatGPT in the field of ICU diary, there are some studies that summarized and discussed ChatGPT's application prospects in ICU fields, which can give us inspiration on the potential application in ICU diary.

ChatGPT's application prospects in current ICU fields	Author	ChatGPT's inspiration & opportunities for ICU diary	Examples of queries in ChatGPT (OpenAI, 2022)	The limitations and risks
Data extraction and summary	(Lu et al., 2023)	1. Writing accurate summaries based on the input diary entries 2. Organising diary entries by creating folders based on content to make it easier to manage	[Providing the situation of the patient on July 4th and summarising] "What was the patient like on July 4th?" [Foldering the diary entries based on the content] "Open the diary entries about the patient's progress written by relatives in a month"	Data privacy and security (Sallam, 2023)
Enhancing communication between healthcare professionals, patients and their relatives	(Abbey, 2023)	Translating technical information in an easy-to-understand way	[Explaining technical information in lay terms] "Explain the patient's medical situation in lay terms"	Misuses (Sallam, 2023)
Provide writing guidance on the medical documentations	(Salvagno et al., 2023)	Assisting nurses in the writing process of the diary, and assisting with tasks such as language and content.	[Providing suggestions of the subjects of diary entries] "Give me a suggestion about the subjects." [Editing the diary entries] "Shorten the entries in 20 words." "Add some words of encouragement for patients and their families. "	Might provide biased answers

Table 3: Current research on ChatGPT in ICU & inspirations for ICU diary

5.4 ChatGPT in other fields

This section shows more possibilities to provide support in text-based conversations and in generating contextually relevant responses in other fields, which can be inspiring for this project.

Figure 23 shows how Duolingo leveraged ChatGPT to help it deliver highly personalised language lessons, affordable and accessible English proficiency testing and more. Duolingo Max is a new subscription that gives learners access to two new features and exercised based on the GPT-4: Explain My Answer and Roleplay. Explain My Answer offers learners the chance to learn more about their response in a lesson (whether their answer was correct or incorrect!) By tapping a button after certain exercise types, learners can enter a chat with Duo to get a simple explanation on why their answer was right or wrong, and ask for examples or further clarification. Roleplay allows learners to practice real-world conversation skills with world characters in the app. These challenges, which earn XP, will live alongside the path as one of the "Side Quests" learners can access by tapping on the character. What will you talk about? We'll guide you through different

scenarios! Learners might discuss future vacation plans with Lin, order coffee at a café in Paris, go furniture shopping with Eddy, or ask a friend to go for a hike.
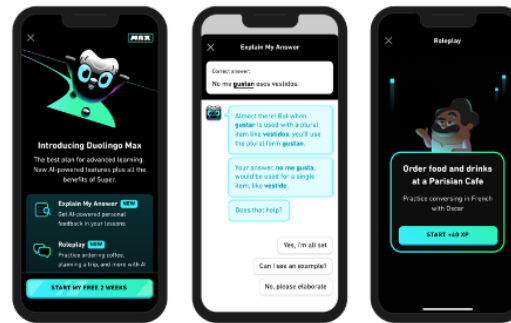
Figure 23: Duolingo Max (Duolingo Team, 2023)

Figure 24 shows Be My Eyes, which is a visual assistant mobile app for those who are blind or have low vision. The incorporation of OpenAI's computer vision technology into the Be My Eyes app has unlocked new dimensions of accessibility and empowerment. By expanding the app's capabilities beyond live video assistance, users are now equipped with the ability to navigate and understand their environment in real-time through AI-enabled object, colour,

and text recognition. This advancement serves as a beacon of technological progress that amplifies independence, enabling visually impaired individuals to make informed choices and engage more actively with the world around them.

Figure 24: People using Be My Eyes (DiBenedetto, 2023)

Figure 25 shows Khanmigo, an AI-powered assistant that functions as both a virtual tutor for students and a classroom assistant for teachers. It can guide students as they progress through courses and ask them questions like a tutor would. AI can assist teachers with administrative tasks, which saves them valuable time so they can focus on what's most important—their students.

Khan Academy is running Khanmigo as a pilot to explore AI responsibly. Early participants will be watching for errors, especially in math questions, and flagging them for correction. One of GPT-4's chief capabilities is being able to understand freeform questions and prompts. That ability—to have a human-like back and forth—provides Khan Academy with perhaps the most key capability: asking each student individualized questions to prompt deeper learning. Adapting GPT-4 for teachers is also top of mind for Khan Academy. The nonprofit is testing out ways teachers could use GPT-4, such as writing classroom prompts or creating instructional materials for lessons.

OpenAI is working with Stripe to commercialize its generative AI technology (Stripe, 2023). Using Stripe's suite of products, OpenAI was able to launch a global payments system for multiple product lines in a matter of weeks. Stripe has long used artificial intelligence to enhance its products and experiences for users, including helping users manage fraud and increase conversion rates. After joining the GPT-4 beta in January, Stripe identified a range of ways to use the technology to streamline operations and help users get the information they need, faster. The enhancement to Stripe's high-quality documentation will allow developers to pose natural language queries within Stripe Docs to GPT-4, which will answer by summarizing the relevant parts of the documentation or extracting specific pieces of information. This lets developers spend less time reading and more time building.
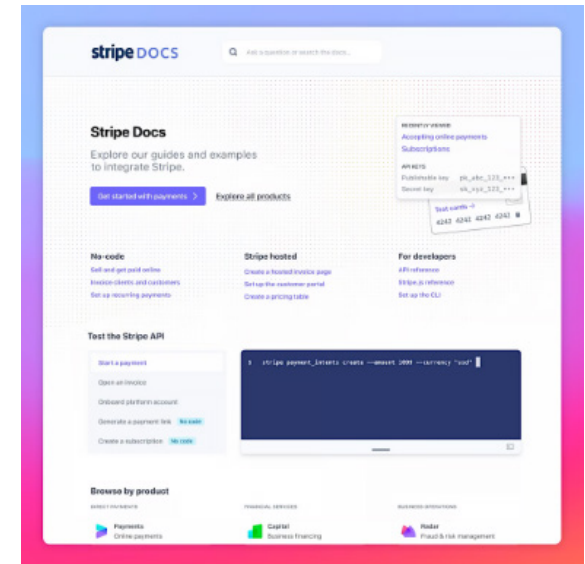
Figure 26: Stripe (Stripe, 2023)

Figure 25: Khanmigo (Khan, 2023)

06 Concept Development

In this chapter, design opportunities are derived and presented based on the previous research conclusion. Design goal and design requirements are defined according to the design opportunities. Three concepts were developed and a ChatGPT-based assistant was built in Python. The design iteration was divided into two parts: interfaces and ChatGPT-based assistant. From the former, the interfaces and user flow were iterated. While from the latter, the assistant was iterated by formulating 3 prompt templates according to the 3 corresponding functions. And a user test was conducted to gather the feedback and design improvements from nurse's perspectives.

Concept Development

6.1 Design Opportunities

How might patients' ICU narratives from the literature review contribute to the design?
- Classify the information that is highly recommended to be written in the diary
- Set up a journey of diary writing based on the four key points and three phases of the patient's ICU narrative

How might Post-ICU integrate into the current nurse system?
- Visualise the patient's information that nurses can write in the diary in the nurse's workflow
- Daily diary reminder in the nurse's system
Diary writing planner based on the journey of diary writing

How might ChatGPT integrate and support using Post-ICU?
- Provide examples of diary entries on certain subjects
- Provide diary subject suggestions
- Generate summary from certain types of diary users

6.2 Design Goal

Integrating these design opportunities, a comprehensive design goal is formulated:

"I want to design interfaces that involve visualising the patient's information in the nurse's workflow, reminding nurses to complete the diary and introducing a ChatGPT-based solution in the working process of writing the diary, thus supporting the implementation of Post-ICU in the current nurse system."

6.3 Design Requirements

Intuitiveness
The design should provide comprehensive and relevant information of patients. It should integrate and visualise information in the nurse's workflow in a straightforward and easy-to-understand manner that supports non-experience nurses to use Post-ICU.

Efficiency
Nurses are often required to deal with a lot of tasks in a working day and they usually work on the documentation in a short time. The design should streamline processes of using Post-ICU (such as the suggestion of diary subjects) and help nurses write effective messages with limited time.

Adaptive
The design should be considered to adapt to different situations of patients and nurses, whether it's for different nursing shifts, different patient situations, different stages of a patient's progress or different stages of a nurse's shift.

Effectiveness
The design should provide an effective solution for nurses in using Post-ICU, whether in the working process of writing the diary or in the working process of offering the diary, thus helping them construct a more complete patient ICU story during the ICU stays.

Data Privacy and Security
Since the diary involves patients' personal information, the design should consider patients' data privacy and security. Also, whether the data can be shared or not should also be considered in the design.

6.4 User Scenarios

Scenario 1: Daily tasks review and diary entry reminder

Before starting shift, nurses login the system to check the schedule of a working day. The dashboard provides visual representations of data, such as daily task, appointments with relatives or doctor, emergency flow, and used patient room. Also, the diary entry reminder is set to ensure the daily diary-writing from nurse's perspective.
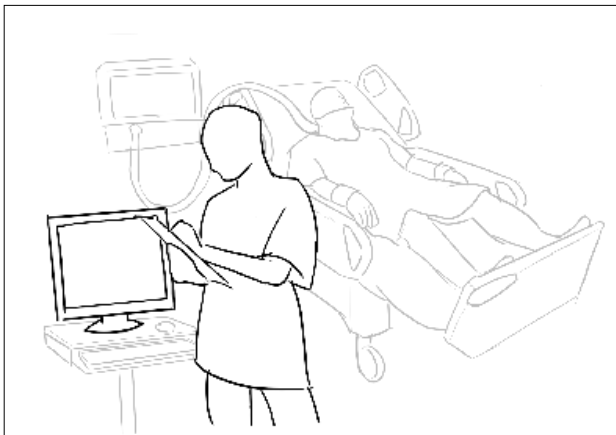
Scenario 2: Assist nurses in diary-writing

After finishing the medical tasks, nurses usually sits in the observation unit and use computer to work on the documentation. In this case, nurses could open patient diary and start to write the diary entry.

Figure 27: User scenario 1

Figure 28: User scenario 2

6.5 3 Initial Concepts

Based on the design goal, design requirements and user scenarios, the low-fi wireframes and related flow of 3 initial concepts were formulated for the further interface design and implementation of the possible functions of ChatGPT.

Concept 1 was a web application - Patient Diary Toolkit - that visualises patient information in the nurse's workflow, provides a ChatGPT-based solution to assist nurses when writing the diary, and sets reminder for daily diary writing. The detailed wireframes and flow of Concept 1are shown in **Figure 29**.

It consists of two key modules: Dashboard view and Patient Diary view. Dashboard view is presented the daily tasks of nurses and their appointments with relatives. Also, a diary writing reminder is presented to give the real-time and effective reminder, thus ensuring the daily diary entry from nurse's perspectives. The dashboard also shows the real-time Emergency Department Flow and Used Operating Room rate to help nurses know about the status of the ICU in a quick glance. In the Patient diary view, there are three important modules

that help the integration of the diary in the workflow and support nurses in writing the diary. Existing Diary module allows nurses to read patient diary they are responsible for and add new patient diary. While in the Add Messages module, nurses can write the daily diary entry. They can fill in some information based on the presented layout of the diary entry. A ChatGPT-based assistant is presented to help them in the diary writing. They can start a new conversation by clicking the assistant and then ask for help. Diary Planner module visualises the patient ICU journey and patient information according to the nurse's workflow so that the nurses will gain an overview of what information are important to be written in the diary and what they could write after a working day.

Patient Diary view

Existing Diary

Add Messages

Diary Planner

Dashboard view

A:ChatGPT-based Assistant

Layout of the diary entry
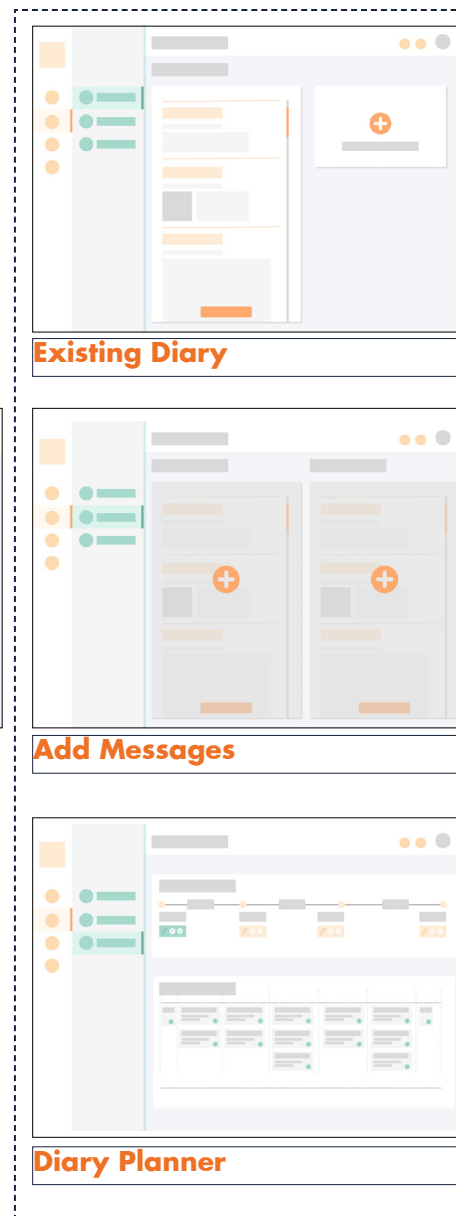
ChatGPT-based Assistant

Figure 29: Low-fi Wireframes & user flow of Concet 1

Concept 2 is similar to Concept 1 but has some differences in the interactions of adding messages. The process of writing is finished through the conversations with the assistant. Nurses write their diary entries in the dialogue and give an instructions of how assistant can help them such as rephrasing the language style or checking the grammar. The assistant will response based on their inputs. By calling the ChatGPT API, the assistant could provide informative and personalised responses compared to the general chatbot system in the Post-ICU Diary. The detailed wireframes and user flow are shown in **Figure 30**.

Patient Diary view

Existing Diary

Add Messages

Diary Planner

Dashboard view

B:Conversational Assistant
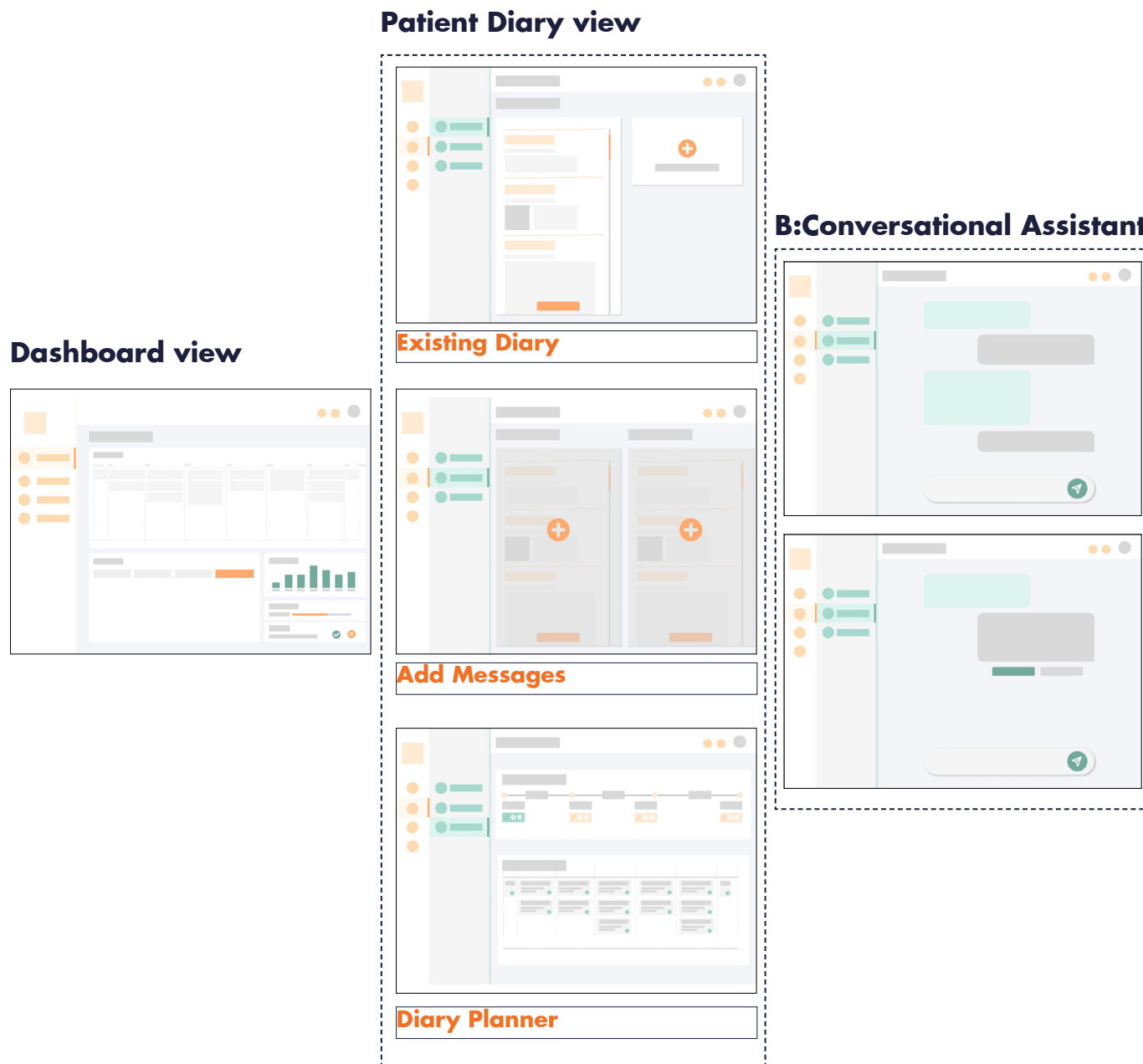
Figure 30: Low-fi Wireframes & user flow of Concet 2

Concept 3 builds on Concept 1. It presented two ways about the interactions with the assistant. The first one is to allow the nurses to start a conversation with the assistant on their own, giving them freedom to explore what the assistant can contribute to their diary writing. The second one is to provide clear and understandable prompt templates to help them start a conversation to ensure the conversations on track and get the outputs that fits their expectations. The detailed wireframes and user flow are shown in **Figure 31**.
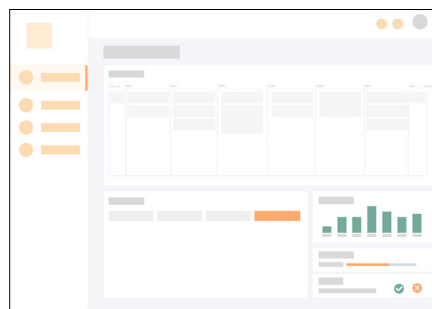
Patient Diary view

A:ChatGPT-based Assistant

Existing Diary

Dashboard view
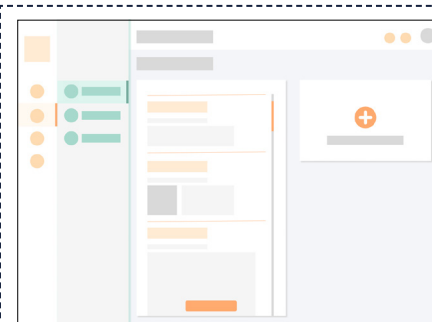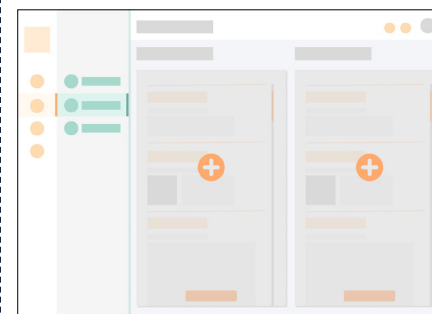
Add Messages
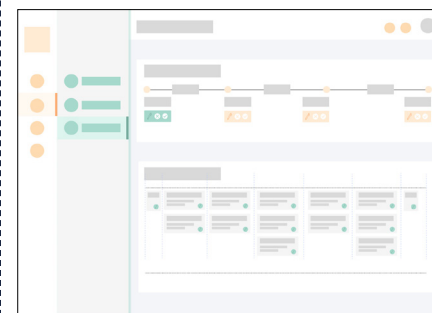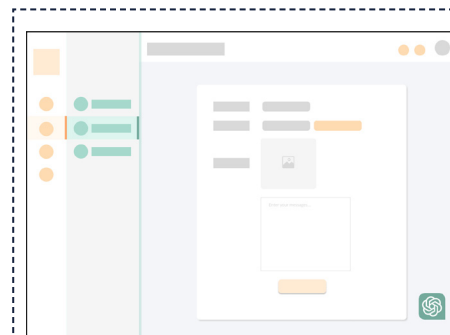
A1: Prompt templates

Diary Planner
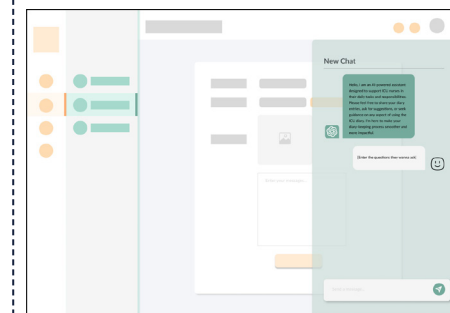
A2: Start a new conversation

Figure 31: Low-fi Wireframes & user flow of Concet 3

6.6 ChatGPT-based Assistant setup

Context setup

ChatGPT first needs to understand the context and purpose of the ICU diary. It should be aware that the diaries are meant to document the patient's journey, medical updates, emotional support, and interactions with ICU nurses. It is provided for patient and it is written by nurses and patient's families.

Function Setup

ChatGPT can provide valuable functions for diary when ICU nurses are writing ICU diaries to help them write important information and capture their feelings related to patient daily care. Based on the design opportunities, there are three defined functions for the ChatGPT implementation in the ICU diary which were shown as follows:

1. Generate diary subjects and ideas.

The nurse can start a conversation with ChatGPT, explaining that they are unsure about what to write in the ICU diary. This can be done by providing some prompting questions from ChatGPT and letting them choose the one fits their situation.

2. Help nurses express emotional feelings by rephrasing their language style.

ChatGPT can assist in framing the entries with appropriate language and tone. For example, it can suggest empathetic phrases for expressing nurse's own feelings or it can provide understandable and precise description for updating medical progress.

3. Provide a examples of diary entry based on the topic nurses would write.

By describing the topics nurses would write, patient's situation and their working shift, ChatGPT could assist nurses who are unsure about how to write their diary entries by providing some examples of diary entries, which could include various aspects of patient daily care.

Prototyping

The ChatGPT-based assistant was build in Python and the code was shown in **Figure 32**. The initial instruction is:

"I want you to act as an ICU diary assistant. Nurses needs to write patient's daily life in ICU in the diary everyday. Based on the inputs, you will help ICU nurses in writing the diary entry. You will be required to generate diary subjects and ideas, rephrasing the language style of their diary entry, and providing an example of diary entry based on the topic they input."

ChatGPT-based assistant

Figure 32: The code and interface of the prototype

6.7 Design Iteration - Interfaces

In this section, two A/B tests have been conducted orderly to gather feedback on the interface design presented previously and determine the final design directions for further ChatGPT implementation. Firstly, an overview of the testing process will be presented and then based on the results, the interface design went through an iteration and the final interface design was formed.

Participants

In this test, it's important to focus on the fundamental usability and intuitiveness of the interface. Designers are qualified to participate and provide design improvements about the interfaces. 3 Design students were invited in the test.

Procedure

Firstly, the demo of Post-ICU diary was presented which gives an overview to the context of the project. And the design and the goal of this test were explained. Then, participants were asked to complete design-related tasks using all versions of design. In the end, they were asked to provide their ratings and comments using a scale and open-ended questions. Including participant feedback, and ratings, were analysed to determine which version of the design is better. The results were helpful in ChatGPT implementation for design improvements.

Testing 1: User flow of Add messages

Task: Locate the 'Add messages' function in the interface and add a message in the diary. The result of testing 1 is shown in **Figure 33**.

Findings

- The selected version streamlines the user flow and reduces the time burden on the user.
- In the selected version, the diary entry template provides a more intuitive and direct way for nurses to start adding messages and the click action to use ChatGPT plugins offers a natural interaction that aligns with user's expectations of this function.
- It is advisable to set more basic information in the diary entry template, such as the author and the topic of diary entry.

A:ChatGPT-based Assistant ✅

Layout of the diary entry   ChatGPT-based Assistant
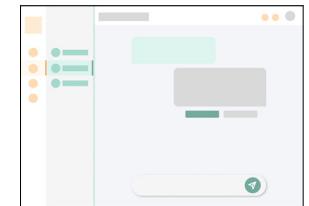
B:Conversational Assistant

Figure 33: The results of testing 1

Testing 2: ChatGPT-based assistant functions

Task: Locate the 'ChatGPT-based assistant' function in the interface and start a random conversation or start a conversation with specific functions in the ChatGPT according to two different design. The result of testing 2 is shown in **Figure 34**.

Findings

- The selected version sets the scope for the design of the prompt and provide three most useful functions for nurse's diary-writing, which reduces the learning, time and cognitive burden on the user.
- From a design point of view, to get the most out of ChatGPT in using diary, not only its in-context capability should be relied upon, but the prompt should also be carefully designed. By following prompt design principles and designing proper prompt ensure the accuracy and effectiveness of outputs from ChatGPT. The prompt design were discussed and iterated in the next section.
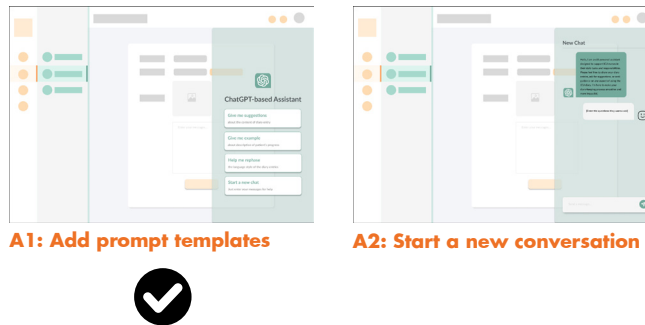

A1: Add prompt templates   **A2: Start a new conversation**

Figure 34: The results of testing 2

6.8 Design Iteration 2 - ChatGPT-based Assistant

Prompt setup & Iteration

As mentioned before, it is of vital to design a proper prompt that drive the effective, high-efficiency and informative conversations with ChatGPT. In order to get well-defined prompts, a ChatGPT-based chatbot was built to help us design and iterate prompts based on the three functions. After iterating the prompts, the prompts templates were formulated and the corresponding interface and user flow were developed which were shown in the next chapter.

Prototyping

Based on the guidelines of designing a prompt from the previous chapter, a ChatGPT-based prompt reviser was set up by using Python. The code was shown in **Figure 35**. It was required to follow the instructions as follows:

"I want you to become my prompt reviser. Your goal is to help me craft the best possible prompt for my needs. The prompt will be used by users. You will follow the following process:
Based on my inputs, you will generate 2 sections.
Revised Prompt (provide your rewritten prompt. it should be clear, concise, and easily understood by you)
Questions (ask the 5 most relevant questions pertaining to what additional information is needed from me to improve the prompt)."

According to the three defined functions of ChatGPT's implementations in the Post-ICU, the act and the corresponding prompts were listed in **Table 4**. Each basic prompt suggested the target user - ICU nurses - and illustrates their needs that is relevant to diary-writing. The ChatGPT-based chatbot

provided a revised prompt and 5 questions pertaining to what additional information is needed to improve the prompt. The iterations was ended if there were no more information that needs to be provided by nurses. The iteration flow was shown in **Figure 36**.

Figure 35: The code of prompt reviser

Functions	Basic Prompts
"Generate diary subjects"	"Please generate diary subjects of ICU diary for ICU nurses to help them figure out what should be written in the diary. "
"Rephasing language style"	"Please rephasing the diary entries for ICU nurses. The language could be empathetic and encouraging."
"Provide examples of diary entries"	"Please provide an example of diary entries for ICU nurses about describing a patient's progress/daily hygiene/entertainment/sleep situation/patient's expressions."

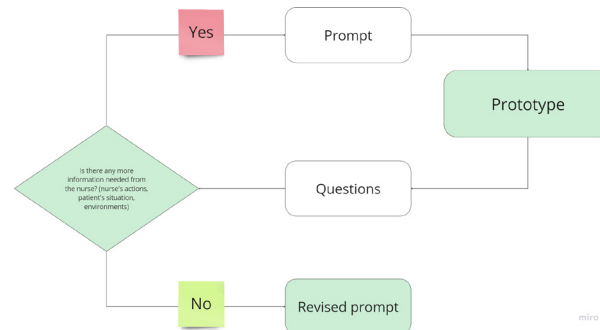Table 4: The three functions and corresponding prompts

Figure 36: Prompt iteration flow

Figure 37: The interface of prompt reviser

Results

The results - template of the revised prompt - were listed in the **Table 5**. Each template suggests patient's situation, nurse's working shift and classification of information that are needed from nurses. By providing prompt templates and letting nurses to invoke it, it was expected to be a efficient, effective and user-friendly way for nurses to take advantage of ChatGPT better in the diary writing.

Act	Basic Prompt	Template of Revised prompt
"Generate diary subjects"	"Please generate diary subjects of ICU diary for ICU nurses to help them figure out what should be written in the diary. "	As an ICU nurse in the [morning/evening] shift, what non-medical updates or subjects about [patient's progress/daily personal care/nurse's feeling/environment/etc] can I include in the ICU diary for [unconscious/conscious] patient?
Rephasing language style	"Please rephrase the diary entries for ICU nurses. The language could be empathetic and encouraging."	Please rephrase my diary entry for a [unconscious/conscious] patient. This is my today's diary entry: [Enter your diary entry here]. The language could be more [what kind of emotions(e.g. empathetic and encouraging)]
Provide examples of diary entries	"Please provide an example of diary entries for ICU nurses about describing a patient's progress/daily hygiene/entertainment/sleep situation/patient's expressions."	Please provide me an example of diary entry for a [unconscious/conscious] patient about [patient's progress/daily personal care/nurse's feeling/environment/etc]. [Specific requirements: limited words/etc]

Table 5: Results of iteration & 3 prompt templates

6.9 Design Iteration 3 - User testing with experts

After the iteration of the interfaces and ChatGPT-based assistant, a user testing was conducted to gather feedback on the interfaces and the prototype of ChatGPT-based assistant presented previously. Participants were first introduced to the goal of this testing and an overview of the testing process and then they were allowed to experience the prototypes. Then a semi-structured interview was carried out with participants about their opinions on improving the design. Data will be analysed by coding the answers from the interview.

Procedure

1. Participants are introduced to the context of the project, including why using ChatGPT-based solution to support nurses in writing the diary.
2. Participants are introduced to the design and the basic user flow of this design. Then they are allowed to experience the interfaces and the prototype. They are encouraged to express their opinions and ideas during the testing. The flow of the tested prototype is shown in **Figure 38**.
3. A semi-structured interview is carried out with the participants about their feedback on the design for further design improvements.

Participants

There are 3 participants in this user testing. All of them are working in the ICU and are familiar with the Post-ICU diary. And they are working on the implementation of the digital diary in EMC. The profile of participants is shown in **Table 6**.

Participant	Gender	Role	Working experience
1	Female	ICU nurse and nurse researcher at EMC	Worked as a nurse for about 16 years and as a researcher on the implementation of the digital diary for 1 year
2	Female	ICU nurse at EMC	Worked as a nurse for more than 10 years, focusing on the improvement of intensive care aftercare
3	Female	ICU aftercare nurse at EMC	Worked as a nurse for more than 10 years

Table 6: Profile of participants

Results analysis

Redundant information shown in the Dashboard view

When experiencing the Dashboard view, participants mentioned that some information shown has already been included in the current nurse's system such as the nurse's daily tasks and appointments with relatives. They suggested most nurses are quite familiar with their schedule in a working day and it is not necessary for them to check the tasks before the diary writing. They expect to present diary-related information in the Dashboard view.

Reminders to check whether nurses complete the daily diary entry

During the observation, almost all the participants did not notice the diary check. They suggest that it could be more visible for the reminder, which ensures nurses to complete the daily diary entry.

Intuitive and understandable layout of the diary entry

In the Patient Diary view, participants are allowed to read the patient diary and add messages into the patient diary. When reading the diary entries, they said the layout of each diary entry is intuitive and easy to know the author of the diary entry by using the different colours and icons to distinguish. When adding messages, they said it would be better to add the "night shift" options in the layout of diary entry, which is more comprehensive.

3 prompt templates as a way to start a conversation

Considering all the nurses are not working on the digital diary and some of them might not be familiar with ChatGPT, all the participants agreed that using 3 prompt templates is a good way to start the conversations between the nurses and the assistant. Based on the templates, nurses could rephrase them instead of writing a new prompt by themselves, which reduces the time burden and streamlines the process of writing the diary. But it would be better to give a short instruction on how to use these 3 prompt templates.

3 Functions of ChatGPT-based assistant

From the feedback of the participants, this quality has little to do with the 3 functions. It is clear and easy to know how this assistant can contribute to their diary writing and these 3 functions are relevant to the diary writing.

Unexpected factors in the Patient ICU journey

In the Diary Planner section, they mentioned that the vast majority of patient ICU journey did not follow a linear development. Instead, it often develops in twists and turns as there are unexpected factors happen during the ICU stay, such as the patient's condition getting better and then getting worse again. And each patient has a different situation, which lead to different ICU journeys. Therefore, mapping the patient's ICU journey is influenced by the patient real situation during the ICU stay. What is certain, however, is that a patient's admission and discharge from ICU are key moments that need to be recorded in the diary.

More comprehensive and accurate in the Information Visualisation section

All the participants expressed their satisfaction with the Information Visualisation section since it helps nurses to gain a basic overview of what they could write in the patient diary. By clicking on the information, it turns to the Add Messages module and

then allows nurses to start writing. However, it includes some information that is not necessary to be written in the diary such as the patient's overview and patient's medical measures. Also, the title and description of the information could be more accurate and comprehensive.

Insights

Discard redundant information in the Dashboard view

Some information does not contribute to the diary writing as some of them have already been included in the current nurse system and some are not closely related to the working process of diary writing.

Eye-catching Diary Reminder section

The diary reminder should be more visible to ensure nurses know their daily diary task and then complete it.

Add instructions about how to use the prompt templates

Since most nurses were not aware of how the prompt templates could be used for the conversations with the AI assistant, so intuitive instructions should be added.

Comprehensive and accurate information visualisation

Based on the patient information the nurses interact with, the information visualisation should be more comprehensive and more related to the diary. It should be considered to avoid some information that can also be provided from other stakeholders of the patient diary, which reduces the nurse's work burden.
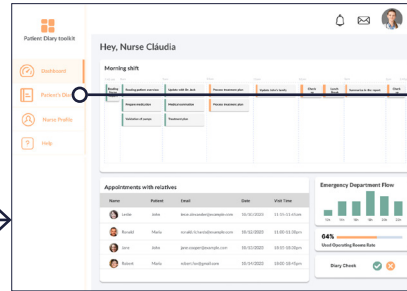
Patient ICU Journey removal

The patient ICU journey is difficult to map since it depends on the patient situation and often be affected by various unexpected factors. Even nurses and doctors could not precisely predict the further development of patient situations. Therefore, this section will be removed.
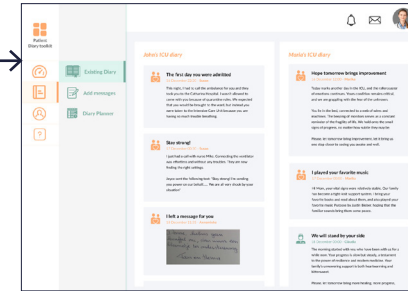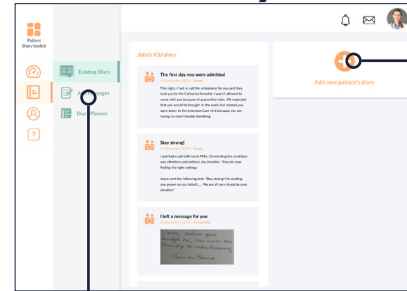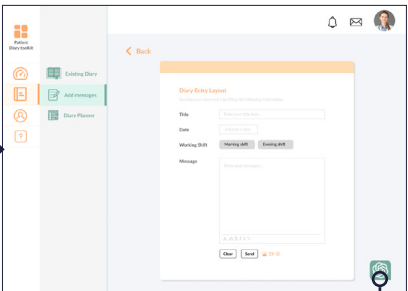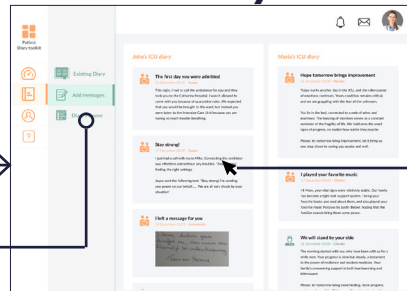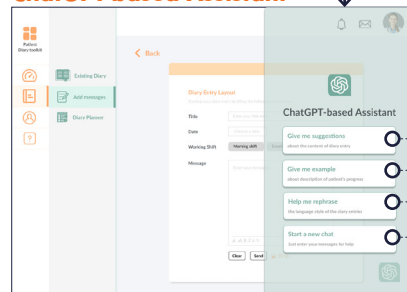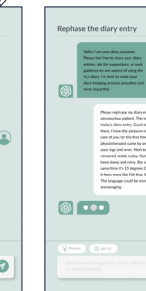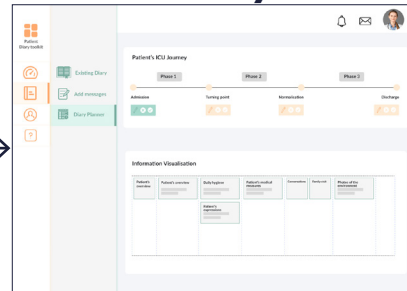
Figure 38: The flow of the tested prototype

07

Final Design
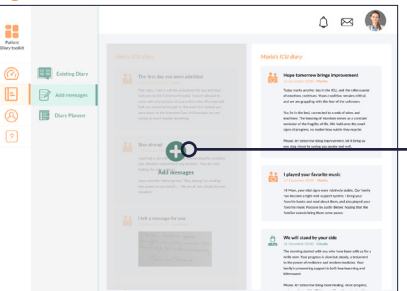
This chapter introduces the final design solution - Patient Diary Toolkit, an web application which integrates the ChatGPT power to support nurses in diary writing. Information architecture and detailed features of the application are presented.

Final Design

7.1 Overview

The final design - Patient Diary Toolkit - is a web application that supports ICU nurses in the working process of writing the digital patient diary, and help the implementation of digital diary in the current nurse's workflow in the future.

After logging in this website by using the hospital account, nurses can start their daily diary writing. By using this application, it tracks the weekly completion of the diary and reminds nurses to complete the daily diary writing. Also, it helps nurses to know what can they write and what should be written in the diary by classifying the diary themes. A ChatGPT-based assistant has been introduced as a way to support them during the diary writing by providing specific diary suggestions, rephrasing the language style and giving the examples as references. In order to help non-experience nurses to start conversations quickly and effectively, 3 designed prompt templates are presented and nurses can revise them based on these templates, thus reducing the time burden and effort burden. Thanks to the ChatGPT's ability, it generates adaptive, effective and informative responses and gives guidance on writing the diary.

7.2 Information architecture

The information architecture is shown in **Figure 39**.
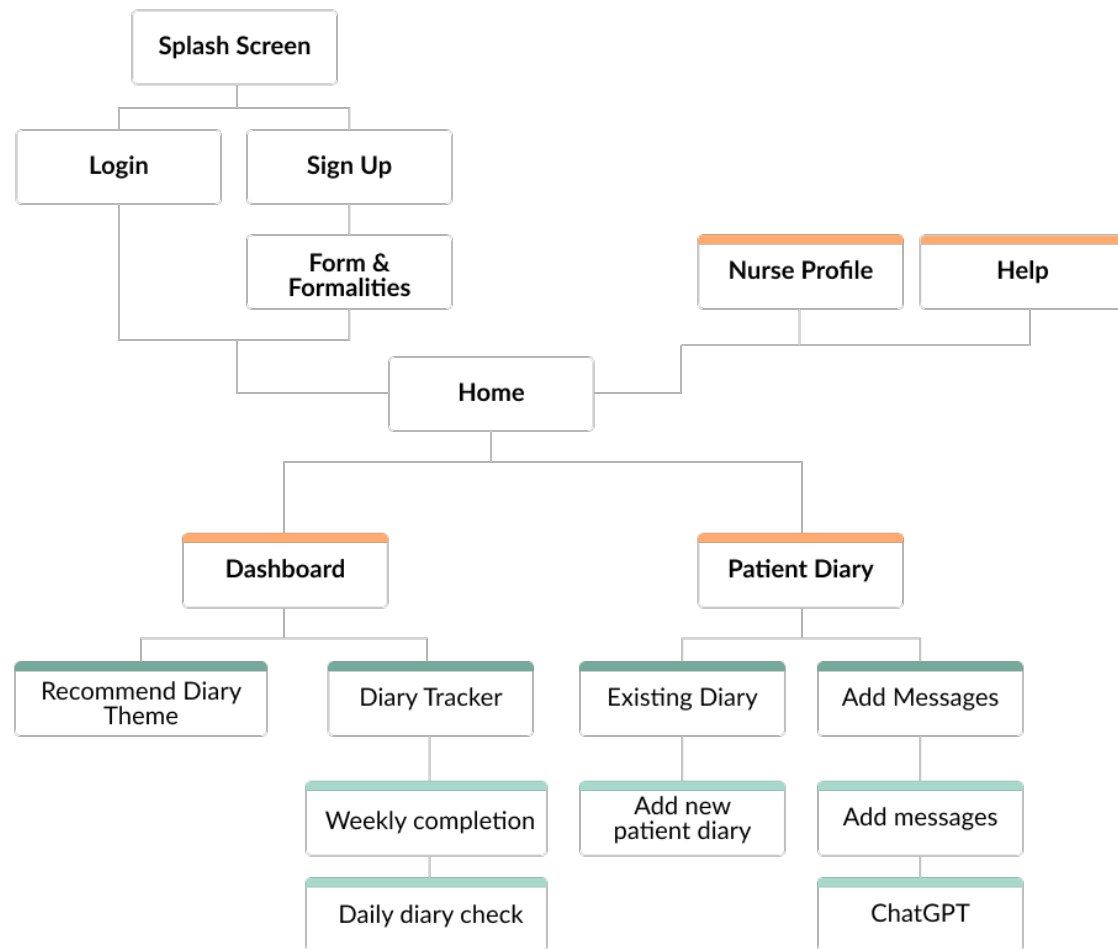
Figure 39: Information architecture

7.3 Features

This section showcases the High-Fidelity model of Patient Diary Toolkit and introduces each page in this web application. The interactive prototype was created using the Figma tool, effectively showcasing the application's pages and their interactive features. The ChatGPT-based assistant was developed by using Python. In this high-fi prototype, the process of the interactions between users and the assistant was stimulated. The actual output from the assistant is realised in the gradio interface, which will also be used in the Design Evaluation phase.

When first opening the website, nurses are prompted to log in by using their hospital account. After this, the name of the nurse is presented and then the nurse could click on the "continue" button to jump into the Dashboard page. **Figure 40** shows the onboarding page and home page. In the next pages, the rest will be introduced detailly.

Final Design Prototype
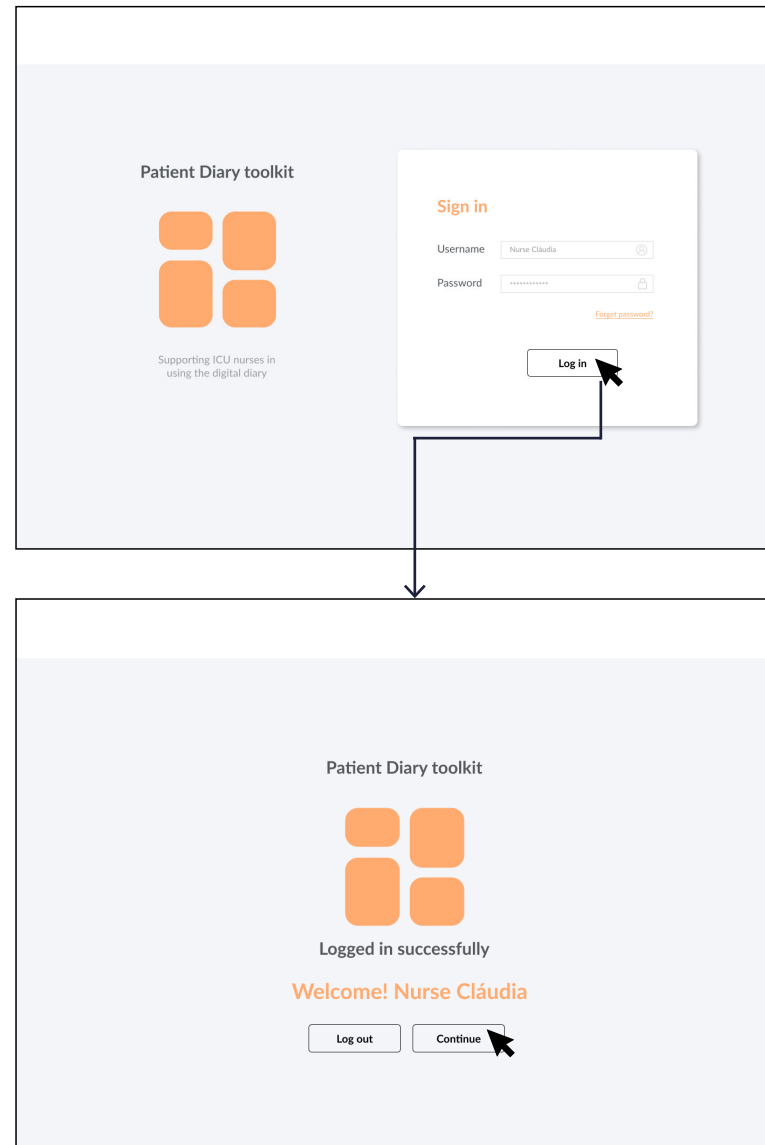
Figure 40: The onboarding and home page of Patient Diary Toolkit

Dashboard page

Dashboard page is presented in *Figure 41*, which displays a comprehensive list of recommended diary themes and offers diary tracker function to remind nurses to complete the daily diary writing.

Recommended diary theme

Based on the insights gained from the literature review and user research, this section is developed to give nurses an overview of the content of the diary. Each diary theme in the interface will represented by a card. The card will display the diary theme, short descriptions about the theme, and a writing button that allows nurses to jump to the Add messages page. To enhance visual clarity and differentiation, colour coding will be implemented to clarify what themes can they contribute to and what themes can also be written by relatives or other professional healthcare.
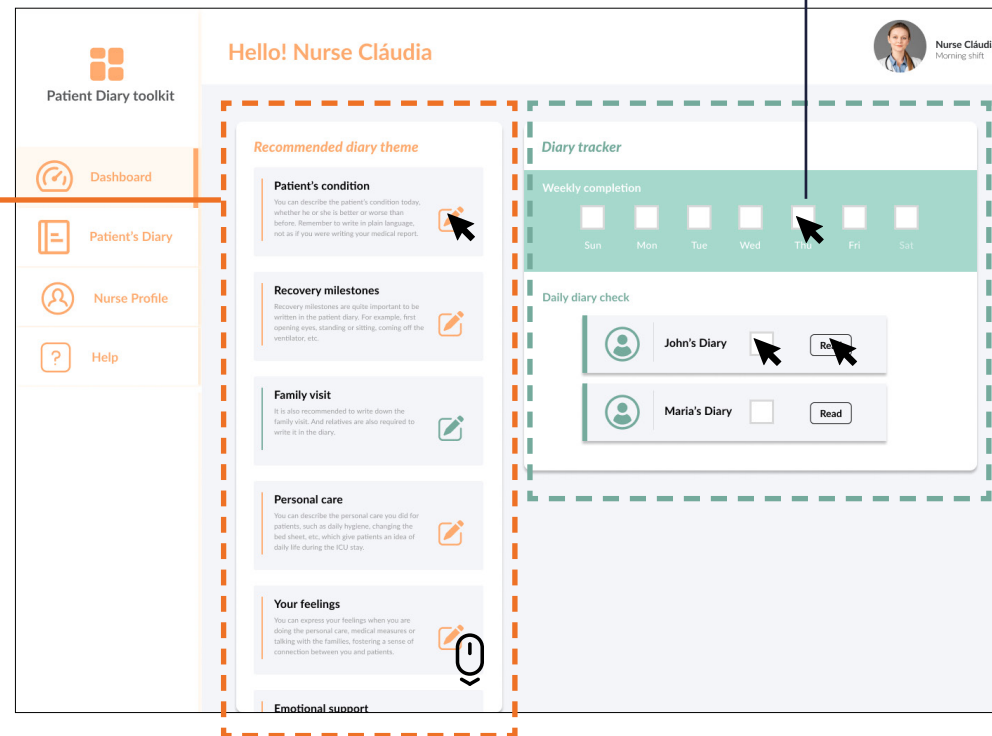
Figure 41: Dashboard page

Diary tracker

Based on the design goal, this section was formulated to remind nurses to complete their daily diary writing. This section consists of two parts - Weekly Completion and Diary Check. Weekly Completion monitor the completion of diary writing in a week. Nurses can click the checkbox if they already finished diary writing on the specific day, so that they can clearly know which day's writing task has been completed and which one has not. While Daily Diary Check ensure them to write the patient diary everyday, ensure the integrity of each patient diary. Nurses could click on the checkbox if they finished the diary writing in a day. The status of all the checkboxes will be reset in the next day. Nurses are also allowed to read each patient diary by clicking on the Read button and the the page will jump into the Exisiting Diary section which will be introduced in detailed.

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Patient Diary page

This dedicated page in **Figure 42** will support nurses in reading and writing the patient diary by providing them with intuitive and efficient interactions. A ChatGPT-based assistant will be introduced in helping them to write.

Exisiting diary

Nurses can navigate to this section by clicking on the "Existing Diary" option within the side navigation bar. In this section, they can view no more than two patient diaries since each nurse is usually responsible for 1-2 patients. The diary entries from nurses and relatives are distinguished by different colours and icons, enhancing content clarity. Also, the title of each diary entry is presented so that the patient would intuitively know what happened at first before reading all the detailed version of each diary entry.

By entering the diary code, nurses could add new patient diary in this page.
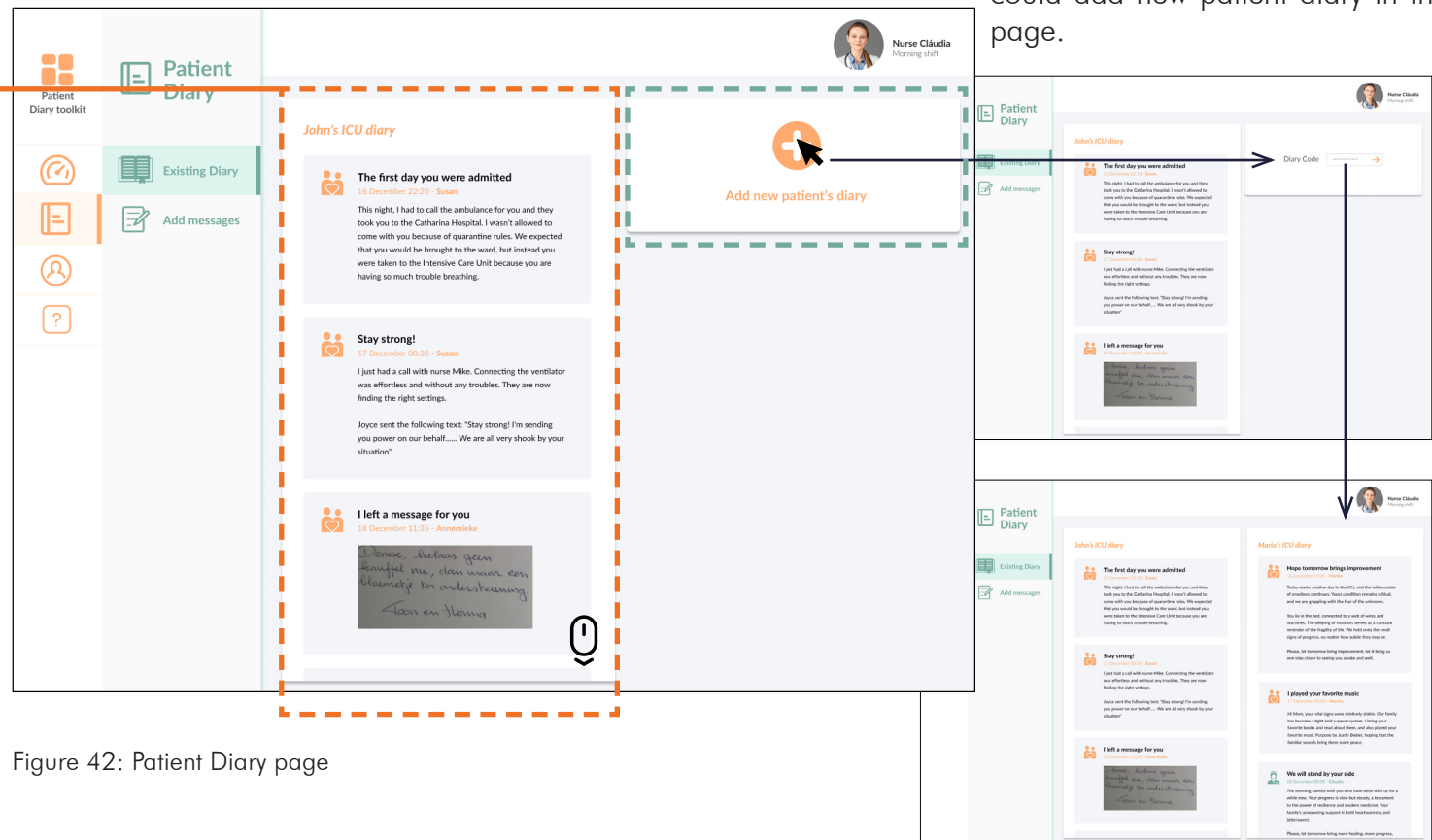
Figure 42: Patient Diary page

Add messages

By clicking the "Add messages" option, nurses can start to add messages in the patient diary. After choosing which patient diary they want to write, there will be a layout of diary entry presented and they are required to fill the relevant information into the layout, such as title, date, working shift and message. They are also encouraged to upload the video if they got permission from the relatives or hospitals.

Diary entry layout

Based on the research on the current ICU diary, the diary entry layout was formulated. By using this layout, it provides a standard of the diary entry and ensure the nurses to complete without missing some basic information. Also, it streamlines the process of the diary writing, reducing the time burden and effort burden of nurses.

Figure 43: The process of add messages and Diary entry layout

New Chat

Diary subject

Rephrase
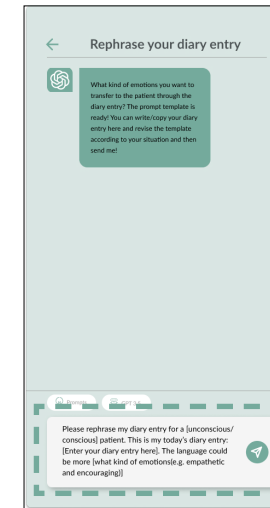
Example
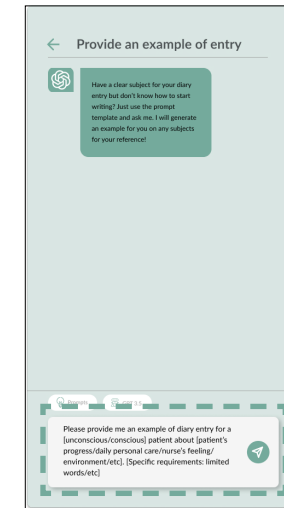
Figure 45: 3 functions and corresponding prompt templates

ChatGPT-based Assistant

Based on the insights from the user research and technology research on ChatGPT and its possible application, ChatGPT-based assistant was set up. It provides three main functions and each function has corresponding prompt templates to start the conversations, ensuring the conversations on track and get the effective responses in a limited time.

Figure 44: Homepage of ChatGPT-based Assistant

ChatGPT-based assistant provides three main functions: providing specific diary subjects, rephrasing the language style and providing examples as reference. Nurses could choose one of the functions and then the designed prompt templates are prepared in the dialogue. The 3 functions and the corresponding prompt templates are shown in **Figure 45.**

Based on the design iteration, the 3 designed prompt templates were formulated, which illustrates the requirement and provide some information that are helpful to get accurate and effective responses including patient situation, nurse working shift and general diary theme. In this way, non-experience nurses could start a conversation quickly and the assistant could provide more comprehensive and personalised responses for nurses.

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Call the prompt templates

If nurses want to start another functions during the conversations, the "prompt" button allows them to call the other prompt templates in any time. By clicking the functions they would like to use, the interface will jump to the corresponding function section and then they can start a new conversation. Nurses could conveniently revise them and send them to the assistant without thinking and describing their problem by themselves. This reduces the cognitive learning burden and time burden of nurses.

Technology

After approximately ten seconds, the assistant will response, providing comprehensive, effective and relevant information for nurses. In this case, it is helpful to support nurses in writing the diary entries especially for nurses who has not been familiar with the digital diary.

With Python, the ChatGPT-based assistant was developed and the interface was presented in the gradio which could allows users to input and get the response. The overview of the prototype coding was shown in the **Chapter 6.6**.
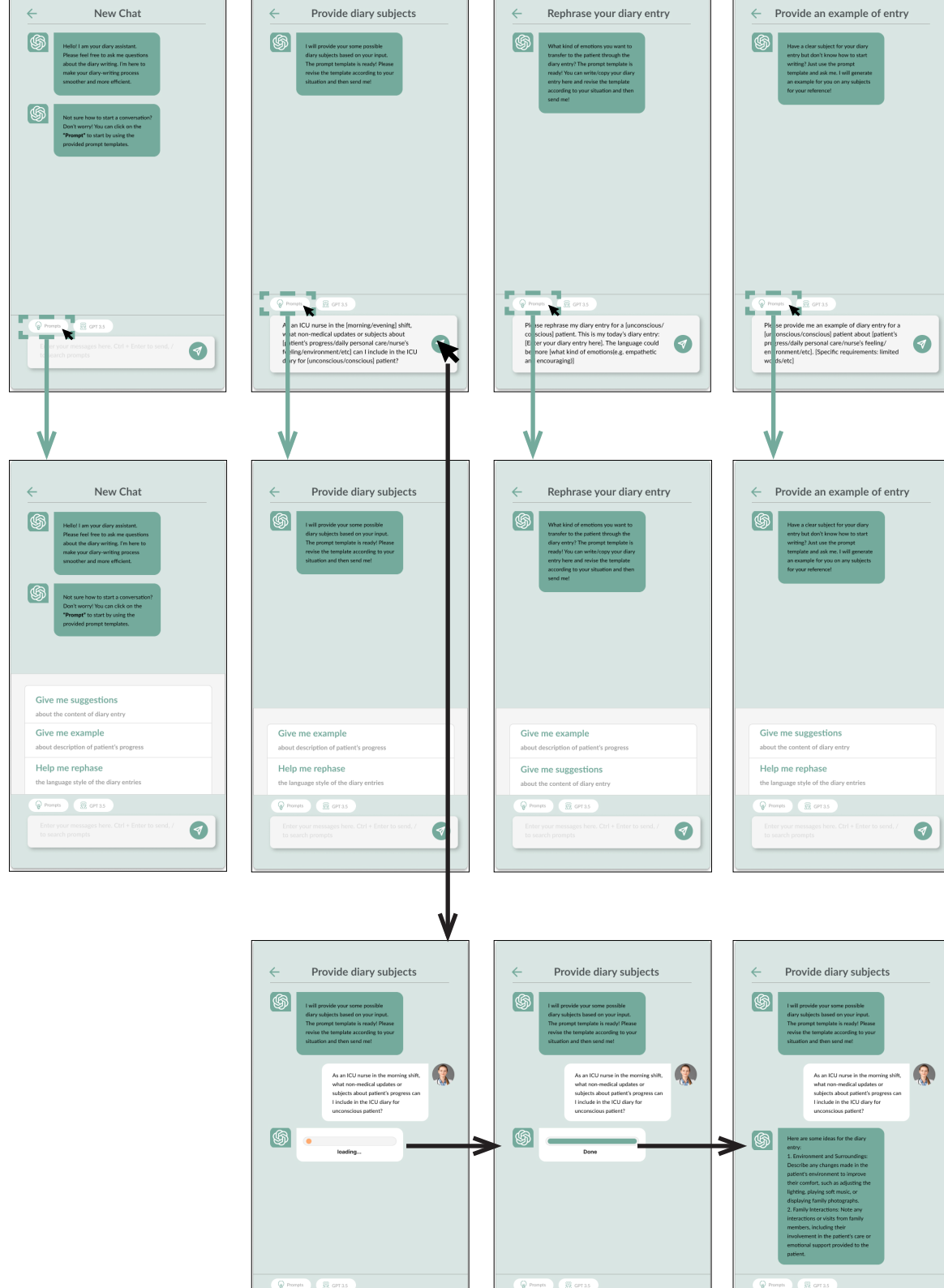
08 Design Evaluation

The final design - Patient Diary Toolkit - was designed and developed. This design was evaluated through user testing and expert interviews, gathering feedback on the usability and the experience of the design. Design improvements and future recommendations were discussed which may be helpful for the later projects.

Design Evaluation

8.1 Purpose of evaluation

The main goal of the evaluation is to prove the final design. This process will be evaluated from two aspects according to the design goal and the design requirements. Here are the two goals that are aimed for:
- Whether the interfaces and interactions are usable.
- Whether the ChatGPT-based assistant improves the nurses' experience in their diary writing.

To achieve these two goals, sub-questions are formulated regarding usability and experience.

Usability
- Are the participants able to execute the tasks independently?
- Do the participants understand all the modules of the application and know what they are used for?
- Does the ChatGPT-based assistant provide support for the participants?
    - Does it provide practical responses for them?
    - Do the participants understand the provided functions and prompt templates?
    - Do the participants find it easy to start conversations with it?

Experience
- How do the participants rate the design on the AttrakDiff scale?
- How do the participants experience the design in terms of
    - Clarity
    - Intuitive
    - Difficulty
    - Supporting/Confidence

8.2 Methodology

The design and prototype were presented to the participants on campus. The AttrakDiff questionniares, as one of the evaluation of user experience questionnaires, were used to evaluate the final design. The usability and user experience were measured from comparative testing. To gain insights into the potential usability issues, the time of finishing each task and the success rate of finishing each task independently were measured. Then the final design was compared to the Post-ICU Diary by scoring both of them in a questionnaire and a semi-structured interview, scoring the usability and the experience. To gain more insights in

the user experience, at the end of the test, the remaining attributes of the AttrakDiff questionnaire were scored on a seven-point scale, as well as the overall experience and estimated future potential.

Participant
Due to the accessibility of ICU nurses in Erasmus and the limited time, the evaluation of the application will be carried out with students by using a role-play test. The user testing involves 15 participants, and most of them is aged from 20 to 30.

The participants were informed of the data collection and usage in this project-based research and design thesis. Their basic information (age, gender and educational background) and their experience with ChatGPT will be required before starting the user testing. All the participants have experience in using ChatGPT. The applications that ChatGPT offers are categorised into three aspects: answering academic questions, rephrasing paragraphs/reports/assignments, and providing ideas for writing.

Procedure

To evaluate the final design - Patient Diary Toolkit - in terms of usability, effectiveness and user experience, comparative testing will be applied. The current way of diary-writing in the Post-ICU Diary was compared to working with the design Patient Diary Toolkit.

1. Pre-experiment: context introduction

The researcher will introduce the workflow of ICU nurses, the current situation of ICU digital diary and the Post-ICU diary in the context of the ICU. And the context and the goal of this project will be illustrated to the participants. Then introduce the process of the testing and let the participants empathise with the situation of an ICU nurse and complete the patient diary.

Scenario setup

"You are Claudia, an ICU nurse, and your working shift is in the morning. You are responsible for two ICU patients, who are John and Maria. John is still unconscious and Maria just got out of a life-threatening situation and woke up. As an ICU nurse to provide emotional support for your patients, it is necessary to complete daily diary writing. The content of the diary includes and is not limited to the following: patient's progress, nurse's actions, nurse's feelings and descriptions of environments. You could also find some suggestions for the diary subjects from the systems."

2. Comparative Testing & Scale

The participants will start to experience the Post-ICU diary and Patient Diary Toolkit with three types of tasks to evaluate the main functionalities of the application: diary review, diary writing and assistant in diary writing. The specific tasks are shown in Table X. Based on the purpose of the evaluation, the attributes in Table X were chosen for participants to evaluate the usability and user experience of the final design by comparing with Post-ICU Diary. The two alternatives are both unknown to the participants, whereby the scales of the questionnaire are a reliable representation of the participant's experiences. The researcher will observe participants as they interact with the application, taking note of their actions, challenges, and feedback. The participants are encouraged to think aloud, expressing their thoughts, impressions, and difficulties encountered during the tasks.

Three types of tasks

Task 1: Review the existing patient diary
- Open an existing patient diary
- Review of the existing patient diary

Task 2: Add a message in the patient diary
- Try to figure out how to add a new message to the patient's diary
- Add a message and check in the patient diary

Task 3: Write a message with the help of the system
- Write a new message about daily personal care in John's diary. (P.S: John is still unconscious)
- Write a new message about milestones in Maria's diary (P.S: Maria just woke up)

Figure 46: Three types of tasks in the comparative testing

3. Post-experiment: final questionnaire and semi-structured interview

After finishing all the tasks and the corresponding questionnaires, the participant will fill in a rating questionnaire to measure the usability and experience regarding the Patient Diary Toolkit. The questionnaire is designed by selecting relevant qualities from the AttrakDiff questionnaire, on a seven-point scale. The qualities measured are

shown in Table X. Then an interview will be conducted to gather their feedback and deeper insights about the application.

Measured after each task
(Scale:1-7) Complicated - Simple Cumbersome - Straightforward Confusing - Clear Impractical - Practical Difficult - Easy While carrying out the tasks I felt: (Scale: 1-7) Insecure - Confident Uncomfortable - Comfortable

Measured at the end of the evaluation
(Scale: 1-7) Traditional - Innovative Bad - Good Distant - Inviting Ugly - Attractive Unprofessional - Professional Uncomfortable - Comfortable I fully disagree - I fully agree (Scale: 1-7) - All aspects were understandable - All aspects were distinguishable - It was clear where I could find everything and know the functions of each section - My general experience with the design was good - I think this application has future potential

Figure 47: Attributes measured after each task & final questionaire

8.3 Results & Analysis

To compare the final design and Post-ICU Diary, both of them were mapped for the averages per task separately. The average scores per task for the two different applications are shown in **Figure X**. The results of the final questionnaire are visualised in **Figure X**.
Combining all the results, has led to insights that can be used to improve the design of Patient Diary Toolkit. These insights are categorised according to the main functionalities of the design.

Reviewing the patient diary
In general, all participants were able to find the existing patient diary and then review the diary in a few minutes, although some of them used more clicks than necessary to finish this task. These participants were explaining what they observed and what they thought. Half of the participants tried to figure out what the dashboard page was used for and they suggested that it did not take much time knowing the content in the dashboard page although it was new for them comparing with Post-ICU Diary. Some of them mentioned that it was more clear for them to distinguish different diary entries by using different colours and icons. The

participants' interpretation of the words and icons in the interface corresponded with the intended meaning. Based on this, it could be said that the interface of the design is intuitive to use and review the information in the patient diary.
"The layout and the colour are clear and intuitive to me. As a non-experience user, I think it saves my time and I can know what it was for in a short time. "

Adding messages in the patient diary
Most of the participants preferred the way of adding messages by providing the diary entry layout since it streamlined the user flow and reduced the time burden.
"I personally like the way you add a message by filling the layout instead of talking to the system and following step by step. It saves a lot of time and it streamlines the process of adding a message in the diary. "

One-third of the participants used the "recommended diary theme" section to start adding a message. They thought that by choosing one of the general subjects they could clearly know what to write and start writing quickly instead of using the "add messages" section, which is easier and

helpful.

"I like the recommended diary theme section. It is clear and intuitive to me because I could easily know what I can write in the patient diary. And it can jump to the Add Messages section by just clicking on the icon."

However, some terminology seemed confusing for some participants, such as "add new patient's diary". Some of the participants misunderstood this word and they thought it was the function to add new messages in the patient diary, which influenced the participants' experiences such as the score of the attributes "confusing-clear" and "cumbersome-straightforward". The misunderstanding terminology is revised after the evaluation. Also, they explained it was confusing to choose one of the patient diaries and then add messages instead of adding messages directly. One participant explained that it would be easier to have some needed information in the diary entry layout, such as the patient's name and the general diary subjects.

Assisting in the diary writing

Since the prototype did not provide actual access to the ChatGPT-based assistant, it was difficult for participants to reflect on the usefulness of the assistant. Therefore, participants could only experience the user flow of the assistant with task 3 and score based on their experiences.

Half of the participants were not aware of the ChatGPT-based assistant besides the diary entry layout at first. 3 participants thought the assistant would be shown in the side feature bar instead of in the "Add messages" section. When guidance was provided by the researcher, participants replied it was logical that the assistant is a part of the "Add messages" section and they suggested that a hint or notification would be better for them to notice the ChatGPT-based assistant and then interact with it.

The participants were positive about the functions of the ChatGPT-based assistant as they were intuitive and relevant for supporting their diary writing. Most participants stated that the way of requesting suggestions in Post-ICU Diary was inconvenient, as they had to follow the directions and sometimes they found it difficult to get useful suggestions in a short time. These participants experienced the Patient Diary Toolkit significantly more practical than the situation in Post-ICU Diary.

However, about a third of the participants felt confused at first when they were aware of the three templates in the dialogue. They stated that it took some time to read the directions from the assistant, which increased their time burden and cognitive burden. 3 participants were doubtful of the reliability of the responses and the content of the responses from ChaGPT by using the templates as the templates were structured and the responses may be similar, which influenced the practicability of this assistant.

"The trust issues of ChatGPT should be considered since you cannot just adopt the results from it. You still have to check it by yourself. "
"The responses from GPT would be similar every time you use the template. The templates would be helpful for non-experience nurses. But if they are familiar with the working process of diary writing and they already know how GPT can help them, will GPT still contribute to their diary writing? "

Overall

When looking at the averages per task, it suggested that the Patient Diary Toolkit was experienced more positively than the Post-ICU Diary. Since these two alternatives were new to the participants, they were slightly overwhelmed at the beginning of the testing. When getting familiar with the interface and experiencing it with three types of tasks, they explained getting used to the interface and being familiar with the main functionalities, led to higher scores.

Looking at the results from the final questionnaire, the interface was easily learnable and it was confirmed by participants stating that the interface came across as intuitive and logical.

All the participants agreed that the Patient Diary Toolkit has future potential. The participants thought this application could support non-experienced users in getting familiar with the working process of using the patient diary as well as writing the diary. However, whether the ChatGPT is a trustworthy technology in the field of ICU should be discussed further.

"Incorporating chatGPT is very practical and the ChatGPT session can be up-to-date, this will give the application more power in the future."
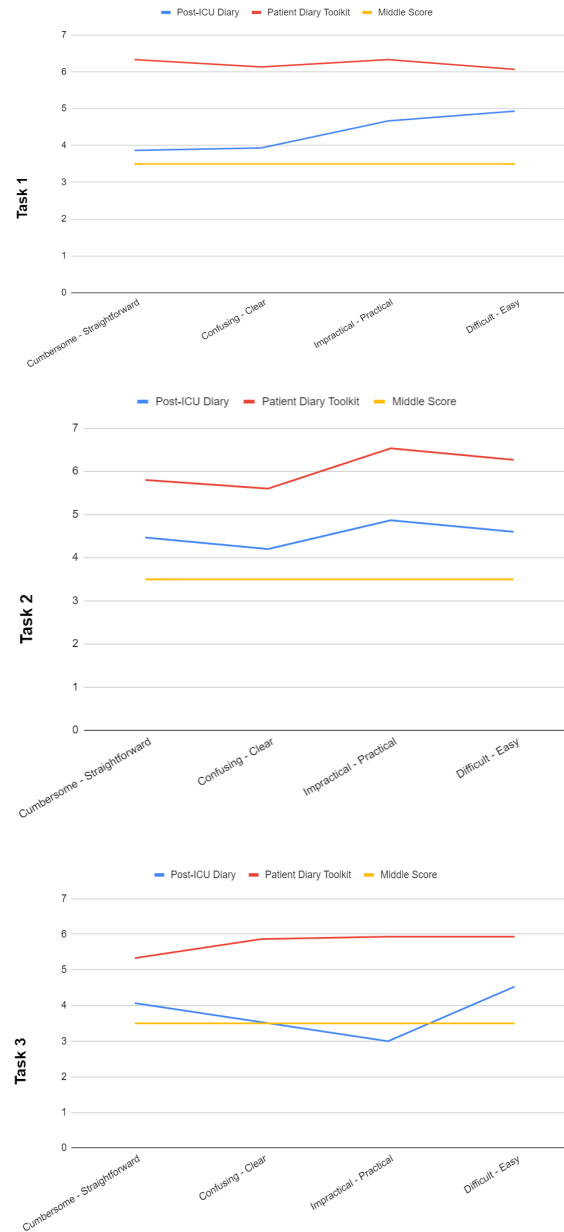
Figure 48: Average scores per task
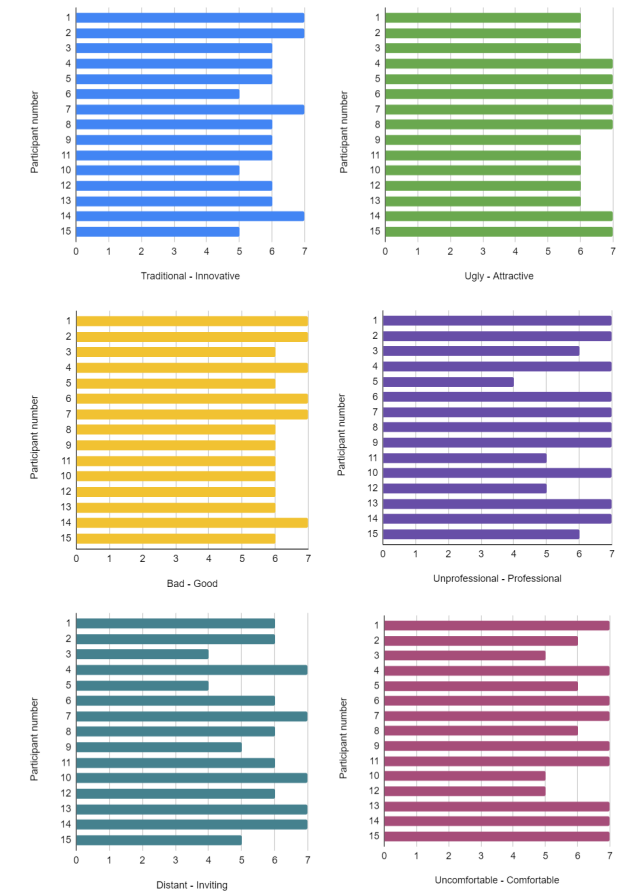
Figure 49: Final questionnaire scores - AttrakDiff
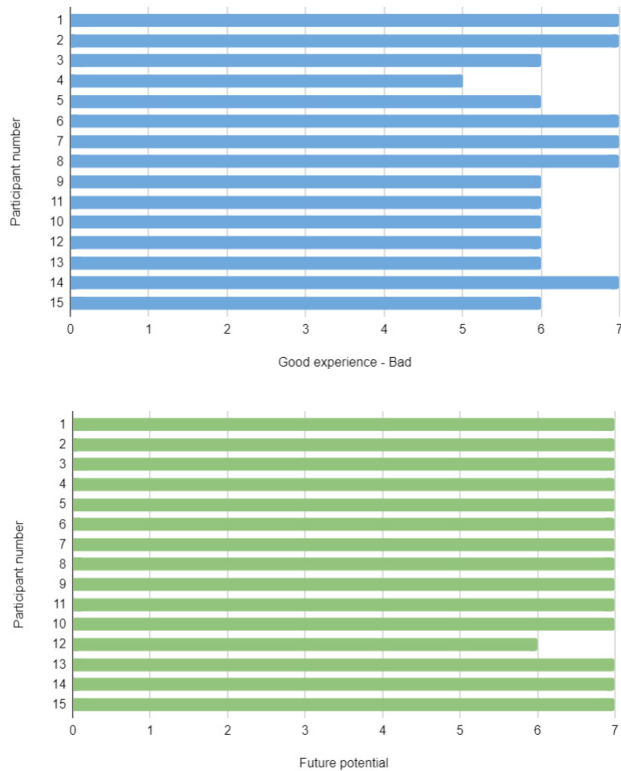
Figure 50: Final questionnaire scores - General

8.4 Expert interviews

Purpose

After the evaluation with users on campus, I expect to conduct several expert interviews regarding the interfaces, interactions and the ChatGPT-based assistant. The evaluation could benefit a lot from the expert's point of view since they could be stakeholders in the whole system related to the design.

To get more comprehensive expert feedback, the developers of the Post-ICU Diary from Games for Health and the healthcare professionals from Erasmus were invited to this expert interview. The former could provide useful advice on how to make the interactions of the ChatGPT-based assistant more fluid and user-friendly by comparing it with the Post-ICU Diary. While the latter could provide some improvements from healthcare professionals' perspectives and validate the possibility of the practicability for non-experienced ICU nurses.

Methodology

The expert interviews were conducted online in the Teams. All experts were given the prototype, explaining the whole functionalities the design could realise. Then they were allowed to experience the

prototype.

The interviews were conducted in two parts, firstly with healthcare professionals and secondly with the developers of the Post-ICU Diary. The interview is semi-structured, and due to the different expertise of the interviewees, questions will also be designed accordingly.

Experts

Margo van Mol

Margo van Mol has worked in the ICU for almost 30 years as a clinical nurse. She holds an MSc in Health Psychology and epidemiology. Margo currently undertakes a post-doc fellowship in the ICU of EMC, an academic hospital in Rotterdam. Her research interests focus on the emotional impact of the ICU on patients and their relatives and the well-being of healthcare professionals.

Carola Schol

Carola Schol is a nurse researcher and PhD candidate in EMC. She has worked as an ICU nurse for about 16 years and then became a nurse researcher for about one and a half years, focusing on the

implementation of the ICU digital diary among ICU nurses in EMC.

Simone Coenen

Simone Coenen is the project manager from Games for Health, which is the company developing the Post-ICU Diary. She has worked on the implementation and activation of the Post-ICU Diary in Dutch hospitals since 2022. Currently, 15 hospitals in the Netherlands are using Post-ICU and another 15 have been contracted. Additionally, 20-30 hospitals are currently in the process of acquiring Post-ICU.

Werner Rutten

Werner Rutten is the software architect from Games for Health. His main role is the technical developer of Whappbot in customer projects and the software developer of the Post-ICU Diary. He has plenty of experience in programming language and structured conversation language.

Valerie van der Looij

Valerie van der Looij is the manager of Communication and Content in the project of Post-ICU Diary. She mainly researches the effects of artificial intelligence and specific language use of chatbots on people, and whether it is possible to provide a user-friendly solution between a person and a chatbot.
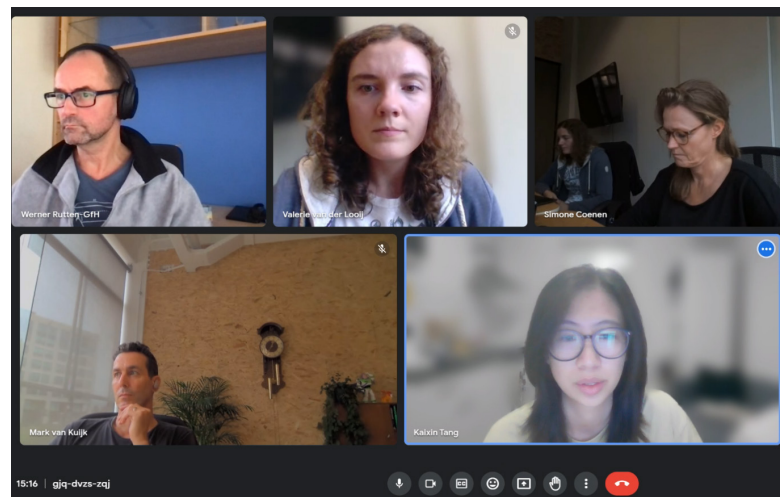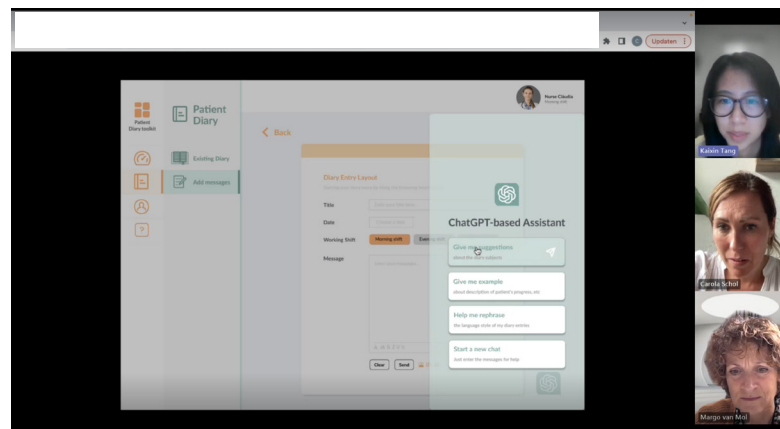

Figure 50: Screenshot of expert interviews

Results & Discussion
The strengths and weaknesses of the design are discussed in the following sections.

Practicability for non-experienced nurses
I have discussed with experts from EMC, whether they feel this design would be practical or not both for the nurses' diary writing and the implementation of the digital diary. The feedback was mainly positive and they mentioned that nurses would lack the experience and they will need guidance at the beginning of using the digital diary. They stated that this design not only validates the functions of the Post-ICU Diary but also provides a personalised AI assistant to support non-experienced nurses. For example, the "Recommended diary theme" section in the dashboard view was said to be helpful and practical for nurses to know what they should write in the patient diary. The functions and corresponding templates of the ChatGPT-based assistant streamline the user flow and offer comprehensive responses for nurses, reducing their time burden and effort burden. There is, however, some specific feedback on the content of the responses. They expected the diary entry to be a day-to-day account of what happened to the patient during their ICU stay, rather than a structured record of daily events. Most of the responses fed by the ChatGPT assistant seem to be structured as the prompts have already been set up, which affects the practicability of the assistant on some levels.

Compared with the Post-ICU Diary
As the experts from Game for Health are currently working on the validation of the Post-ICU Diary and are also thinking about how ChatGPT could contribute to the digital diary, the interview was conducted to gather feedback from their perspectives by comparing the final design with the Post-ICU Diary.

During the interviews, almost all the experts were positive about the interface and the interactions of this design. Regarding the main functionalities of the design, there are some differences between their feedback and the feedback from EMC. As for the interactions of reviewing the diary and adding messages, the experts from EMC gave positive feedback on the diary entries that were distinguished by different icons and colours, and the way of adding messages by using the diary entry layout. However, experts from Games for Health stated that adding messages in a conversational way could provide a human-like experience for users, which is more user-friendly to some users.

Almost all the experts from Game for Health expressed their interest in this ChatGPT-based assistant and praised it. The functions and the corresponding templates were said to be practical for non-experienced nurses in EMC. Their main concern is what is the boundaries of this ChatGPT-based assistant, what it can achieve and what it can not. Also, whether patients' data privacy can be guaranteed when using the ChatGPT is what they thought should be considered most.

09 Summary of the Work

In this chapter, conclusions regarding the overall project are presented. Limitations and recommendations for future are also presented as a reference for those who would like to further research. And personal reflection is included in this chapter.

Summary of the work

9.1 Conclusions

This project starts with the assignment to explore the possibilities of the ChatGPT for ICU digital diary thus supporting ICU nurses' diary writing and the implementation of digital diary in EMC. To reach that goal, the project was divided into four phases, including contextualising, analysing, designing and implementing.

In the contextualising phase, the literature review, observation and user interviews were conducted to dive deeper into the project. The literature review provided an overview of the current state of the ICU patient diary, the context of the diary in EMC, and ChatGPT's inspirations and opportunities. The observation and user interviews gain a deeper understanding of the current nurses' workflow, nurses' challenges, needs and expectations regarding patient diary writing. It highlighted nurses' need for patient information visualisation and guidance in their diary writing. These research activities led to the design goal "Design an application that involves visualising the patient's information in the nurse's workflow, reminding nurses to complete the diary and introducing a ChatGPT-based solution in the working process of writing the diary, thus supporting the implementation of digital diary in the current nurse system."

Based on the design goal, a web application - Patient Diary Toolkit - was designed and developed through three rounds of design iterations. There are basically four main functionalities in this design: reviewing the patient diary, adding messages, diary tracker and ChatGPT-based assistant supporting nurses' diary writing.

This design was evaluated with 15 participants on campus, with the aim of getting insights from users' perspectives about the usability and the user experience of the design. In addition, expert interviews were conducted with healthcare professionals from EMC and developers of the Post-ICU Diary from Game for Health, gathering comprehensive experts' opinions on the design. The results of the evaluation show that the interface is intuitive and easy to understand, and the introduction of the ChatGPT-based assistant offers a practical solution for supporting nurses' diary writing. However, there are some aspects that need to be discussed for further development. For example, the responses from ChatGPT seem to be similar and structured when using the prompt templates all the time. The boundaries of ChatGPT should be clarified and the patients' data privacy should be guaranteed when using the ability of ChatGPT.

In conclusion, the project achieved the goal of designing and evaluating a web application for supporting ICU nurses in their diary writing. The interfaces and the interactions were intuitive and easy to understand. By introducing the ChatGPT-based assistant, it combines ChatGPT's ability with the current work process of digital diary, which seems to be able to support ICU nurses' diary writing and the implementation of the digital diary more smoothly in the context of EMC. In short, the Patient Diary Toolkit is a good start to support non-experienced ICU nurses in diary writing and promote the implementation of the diary in the current nurses' workflow.

9.2 Limitations

While this project brings valuable insights, it is essential to acknowledge the limitations that influenced the outcomes and conclusions.

One of the limitations is the time restrictions. Due to the time restrictions, this project was conducted in a relatively short period and there might be some aspects that could not be explored in as much depth as desired, which influenced the comprehensive of the design. Another important limitation is the user testing in the evaluation phase. Due to the accessibility of the ICU nurses from EMC and the language barriers, the evaluation test was conducted with 15 students from TU Delft with different educational backgrounds. Almost all of them do not know the workflow of nurses at first and are familiar with the work process of ChatGPT, which might be different from the profile of ICU nurses in EMC and influence the outcomes. Last but not least, the integration of ChatGPT technology with the digital diary still needs to be improved, determining the boundaries of ChatGPT and ensuring data privacy.

9.3 Recommendations for future

Further Research: future research could focus on exploring the use of ChatGPT to provide personalised suggestions or content of diary entries to the nurses, rather than providing structured prompt templates. It could also explore other methods of designing the prompt templates and obtaining the responses that fit the expectations of EMC.

Optimisations the ChatGPT-based assistant: the functionalities of the ChatGPT assistant could be optimised considering the security of patient information in the diary entry. For example, the function of rephrasing the language style requires the diary entry, which carries the risk of compromising privacy. Therefore, it could be better to request informed consent from users before this functionality or remove it.

Future-focused solution: ChatGPT offers a great head start for supporting non-experienced nurses and it can build a basis for generating the suggestions or the content of diary entries. However, as the nurses become familiar with the working process of the diary, how ChatGPT assistant could contribute to them is an important topic that should be discussed further. More research will be needed to explore how this technology brings potential value in the field of ICU.

User experience improvement: some users expressed their concerns about the conflicts between the diary entry layout and the ChatGPT-based assistant, as they expected to access these two sections in one interface, which streamlines the process of using the assistant. This problem can be easily solved by presenting the assistant next to the layout instead of clicking and then jumping onto the page of the assistant. The corresponding interactions could also be changed to provide more convenient experiences. For example, by entering some keywords in the "Message" module some suggestions will appear in the working area as a reference for users, which is more convenient and quicker than the actions of copying and pasting.

9.4 Personal Refletions

Looking back to the whole journey of this graduation project, it has been a remarkable learning experience for me and I would like to reflect on myself during the past 6 months. I would say that my graduation project was the most challenging project I have worked on so far. I met difficulties, and unexpected situations, and went back and forth but I have to say that I have learned a lot from this challenging and meaningful journey.

Being the first time in a medisign project, I started with totally no idea of ICUs. One of the difficult parts is that nurses only offer the physical diary to patients' families and the work process of the ICU diary is not involved with nurses in EMC, which was different from what I had envisaged. Therefore, I went back and conducted the literature review on the pilot research on nurses' experience before the implementation of the Post-ICU Diary in EMC and the situation of using the digital diary in other hospitals as a reference. Based on that, I clarified the research questions in the user research and conducted relevant activities to dive deeper into the nurses' challenges and needs. I was struggling to find a way to analyse what I got from the user research and finally mapped out the

insights with some supportive literature. Through the user research, with observations in the nurse station and all interviews with nurses, I gradually gained more knowledge about nurses' workflow and many assumptions regarding the work process of the ICU diary before starting the project were answered.

Another difficulty I encountered was exploring the possibilities of the ChatGPT. Since I did not have much project experience working on AI technology, I immersed myself deeply in literature research and I could not start the design phase as early as I planned. Moreover, there was not a lot of literature on ChatGPT in the field of ICU and it took some time to conclude the insights from the literature about different medical fields with a limited time. The functions the ChatGPT can provide in the final design are not just limited to this. There are still more possibilities that can be explored in the next step.

During the phase of concept development, as an Integrated Product Design(IPD) student, I initially had limited experience in interface design, which I was stressed out and anxious at the beginning, worrying about my limited

ability collided with my perfectionism. Thankfully, the application was designed and iterated through three rounds of tests with the help of design students and experts from EMC, who gave me helpful and professional feedback from their perspectives and never spared compliments on what I did.

It has been a transformative learning experience for me as my bachelor's background is material engineering which is quite different from design. My master's journey has not only broadened my design knowledge but also enhanced my skills in this area, including medical design knowledge, interface design, prototyping, user evaluations, and AI technology. This is the end of my journey as a design student and the beginning of my transition from material engineering to design. I really appreciate the journey of being a design student and working on this challenging project in the past half year. The future career of being a designer is unknown but I am quite excited about it!

Acknowledgement

References

1. Abbey, A. (2023). Artificially intelligent reflection? Smoke and mirrors and a tale of two perspectives. Intensive Care Medicine , 49(5), 609–610. https://doi.org/10.1007/s00134-023-07008-9

2. Akerman, E., Bäckman, C., Egerod, I., Jones, C., Knück, D., Nydahl, P., & Storli, S. (2021). ICU-diary.org. Www.icu-Diary.org. http://www.icu-diary.org/diary/start.html

3. Assaraf, N. (2023, May 25). How to Write ChatGPT Prompts for Email – cloudHQ. Blog. cloudhq.net. https://blog.cloudhq.net/how-to-write-chatgpt-prompts-for-email/

4. Batt, R. (2023, January 12). Prompt Engineering Guide: How to Engineer the Perfect Prompts - Richard Batt. https://richardbatt.co.uk/prompt-engineering-guide-how-to-engineer-the-perfect-prompts/

5. Cheng, K., Guo, Q., He, Y., Lu, Y., Gu, S., & Wu, H. (2023). Exploring the Potential of GPT-4 in Biomedical Engineering: The Dawn of a New Era. Annals of Biomedical Engineering, 51(2023). https://doi.org/10.1007/s10439-023-03221-1

6. Cheng, K., Guo, Q., He, Y., Lu, Y., Xie, R., Li, C., & Wu, H. (2023). Artificial Intelligence in Sports Medicine: Could GPT-4 Make Human Doctors Obsolete? Annals of Biomedical Engineering, 51(2023). https://doi.org/10.1007/s10439-023-03213-1

7. Cohere. (2023). Introduction to Large Language Models. Cohere AI. https://docs.cohere.com/docs/introduction-to-large-language-models

8. Cook, J. (2023). How To Write Effective Prompts For ChatGPT: 7 Essential Steps For Best Results. Forbes. https://www.forbes.com/sites/jodiecook/2023/06/26/how-to-write-effective-prompts-for-chatgpt-7-essential-steps-for-best-results/

9. DiBenedetto, C. (2023, March 22). Be My Eyes meets GPT-4: Is AI the next frontier in accessibility? Mashable. https://mashable.com/article/chatgpt-openai-be-my-eyes-accessibility

10. Du, F. (2021). Roadmap for AI in a humane ICU. Repository.tudelft.nl, 7(2021). https://repository.tudelft.nl/islandora/object/uuid%3Ad8044d71-45fd-422e-a012-14dca50a13b6

11. Duolingo Team. (2023, March 14). Introducing Duolingo Max, a learning experience powered by GPT-4. Duolingo Blog. https://blog.duolingo.com/duolingo-max/

12. Egerod, I., & Bagger, C. (2010). Patients' experiences of intensive care diaries—A focus group study. Intensive and Critical Care Nursing, 26(5), 278–287. https://doi.org/10.1016/j.iccn.2010.07.002

13. Egerod, I., Christensen, D., Schwartz-Nielsen, K. H., & Ågård, A. S. (2011). Constructing the illness narrative: A grounded theory exploring patients' and relatives' use of intensive care diaries. Critical Care Medicine, 39(8), 1922–1928. https://doi.org/10.1097/ccm.0b013e31821e89c8

14. Eric, M. (2022). A Complete Introduction to Prompt Engineering For Large Language Models - Mihail Eric. Www.mihaileric.com. https://www.mihaileric.com/posts/a-complete-introduction-to-prompt-engineering/

15. Experts, E. D. (2023, April 29). What is The ChatGPT API: An Essential Guide. Master Data Skills + AI. https://blog.enterprisedna.co/chatgpt-api/

16. Gewirtz, D. (2023). How to write better ChatGPT prompts (and this applies to most other text-based AIs, too). ZDNET. https://www.zdnet.com/article/how-to-write-better-chatgpt-prompts/

17. Haakma, T., Tieben, R., Sleven, B., Buise, M., & van Mol, M. (2022). Experiences of nurses with an innovative digital diary intervention in the intensive care unit: A qualitative exploration. Intensive and Critical Care Nursing, 70(1), 103197. https://doi.org/10.1016/j.iccn.2022.103197

18. Han, B., Li, Q., Chen, X., & Zhao, G. (2020). Workflow for Intensive Care Unit Nurses: A Time and Motion Study. SAGE

Open, 10(3), 215824402094743. https://doi.org/10.1177/2158244020947433

19. Hendriks, M. M. C., Janssen, F. A. M., Te Pas, M. E., Kox, I. H. J. M., van de Berg, P. J. E. J., Buise, M. P., & de Bie, A. J. R. (2019). Post-ICU care after a long intensive care admission: a Dutch inventory study. Neurosurgery, 9, 12.

20. Jones, C., Backman, C., Capuzzo, M., Egerod, I., Flaatten, H., Granja, C., Rylander, C., Griffiths, R. D., & RACHEL group, T. (2010). Intensive care diaries reduce new onset post traumatic stress disorder following critical illness: a randomised, controlled trial. Critical Care, 14(5), R168. https://doi.org/10.1186/cc9260

21. Jones, C., Griffiths, R. D., & Humphris, G. (2000). Disturbed memory and amnesia related to intensive care. Memory, 8(2), 79–94. https://doi.org/10.1080/096582100387632

22. Kashyap, D. (2023, February 1). Exploring the Capabilities of the ChatGPT API: A Beginner's Guide. Medium. https://levelup.gitconnected.com/exploring-the-capabilities-of-the-chatgpt-api-a-beginners-guide-e9089d49961f

23. Khan, S. (2023, March 14). Harnessing GPT-4 so that all students benefit. A nonprofit approach for equal access! Khan Academy Blog. https://blog.khanacademy.org/harnessing-ai-so-that-all-students-benefit-a-nonprofit-approach-for-equal-access/

24. Komorowski, M., Del, M., & Chang, A. C. (2023). How could ChatGPT impact my practice as an intensivist? An overview of potential applications, risks and limitations. Intensive Care Medicine, 2023(5). https://doi.org/10.1007/s00134-023-07096-7

25. Kumar, N. (2023, May 20). Chatbot vs ChatGPT Differences & Similarities. Spark by {Examples}. https://sparkbyexamples.com/machine-learning/chatbot-vs-chatgpt/

26. LIGS University. (2021). An overview of chatbot technology in healthcare institutions. LIGS University. https://ligsuniversity.com/blog/an-overview-of-chatbot-technology-in-healthcare-institutions

27. Lu, Y., Wu, H., Qi, S., & Cheng, K. (2023). Artificial Intelligence in Intensive Care Medicine: Toward a ChatGPT/GPT-4 Way? Ann Biomed Engineering, 2023(5). https://doi.org/10.1007/s10439-023-03234-w

28. Maagaard, C. A., & Laerkner, E. (2022). Writing a Diary for "You" — Intensive care nurses' narrative practices in diaries for patients: A qualitative study. International Journal of Nursing Studies, 136(12), 104363. https://doi.org/10.1016/j.ijnurstu.2022.104363

29. McCue, T. J. (2023). ChatGPT Success Completely Depends On Your Prompt. Forbes. https://www.forbes.com/sites/tjmccue/2023/01/19/chatgpt-success-completely-depends-on-your-prompt/?sh=5c8d82231a16

30. Nakanishi, N., Liu, K., Kawakami, D., Kawai, Y., Morisawa, T., Nishida, T., Sumita, H., Unoki, T., Hifumi, T., Iida, Y., Katsukawa, H., Nakamura, K., Ohshimo, S., Hatakeyama, J., Inoue, S., & Nishida, O. (2021). Post-Intensive Care Syndrome and Its New Challenges in Coronavirus Disease 2019 (COVID-19) Pandemic: A Review of Recent Advances and Perspectives. Journal of Clinical Medicine, 10(17), 3870. https://doi.org/10.3390/jcm10173870

31. NVIDIA. (2023). What are Large Language Models? | NVIDIA Glossary. NVIDIA. https://www.nvidia.com/en-us/glossary/data-science/large-language-models/

32. OpenAI. (2022). Introducing ChatGPT. Openai.com. https://openai.com/blog/chatgpt#OpenAI

33. Patel, S. B., & Lam, K. (2023). ChatGPT: the future of discharge summaries? The Lancet Digital Health, 5(3). https://doi.org/10.1016/s2589-7500(23)00021-3

34. Post-ICU. (2022). Post-ICU - The Digital Journal for Tomorrow. Post-ICU. https://post-icu.com/

35. Robinson, R. (2023). How to write an effective GPT-3 or GPT-4 prompt | Zapier.

Zapier.com. https://zapier.com/blog/gpt-prompt/

36. Sallam, M. (2023). ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising Perspectives and Valid Concerns. Healthcare, 11(6), 887. https://doi.org/10.3390/healthcare11060887

37. Salvagno, M., Taccone, F. S., & Gerli, A. G. (2023). Correction to: Can artificial intelligence help for scientific writing? Critical Care, 27(1). https://doi.org/10.1186/s13054-023-04390-0

38. Slater, D. (2023). How to Write Better Prompts for Chat GPT. GripRoom. https://www.griproom.com/fun/how-to-write-better-prompts-for-chat-gpt

39. Stripe. (2023, March 15). Stripe and OpenAI collaborate to monetize OpenAI's flagship products and enhance Stripe with GPT-4. Stripe.com. https://stripe.com/zh-cn-nl/newsroom/news/stripe-and-openai

40. Tripathy, S., Acharya, S. P., Sahoo, A. K., Mitra, J. K., Goel, K., Ahmad, S. R., & Hansdah, U. (2020). Intensive care unit (ICU) diaries and the experiences of patients' families: a grounded theory approach in a lower middle-income country (LMIC). Journal of Patient-Reported Outcomes, 4(1). https://doi.org/10.1186/s41687-020-00229-2

41. WeThinkApp, W. -. (2023, January 29). Guide for Crafting Clear and Effective Prompts for ChatGPT Prompting. Medium. https://wethinkapp.medium.com/the-art-of-chatgpt-prompting-a-guide-to-crafting-clear-and-effective-prompts-1dfc2589295b

42. Zhao, W. X., Zhou, K., Li, J., Tang, T., Wang, X., Hou, Y., Min, Y., Zhang, B., Zhang, J., Dong, Z., Du, Y., Yang, C., Chen, Y., Chen, Z., Jiang, J., Ren, R., Li, Y., Tang, X., Liu, Z., & Liu, P. (2023). A Survey of Large Language Models. ArXiv:2303.18223 [Cs]. https://arxiv.org/abs/2303.18223

Appendix

01 project brief

T̃UDelft

IDE Master Graduation
Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Tang	6505
initials	K.	given name Kaixin
student number	5536251	
street & no.		
zipcode & city		
country		
phone		
email		

Your master programme (only select the options that apply to you):

IDE master(s): (★) IPD   ( ) Dfl   ( ) SPD

2nd non-IDE master: _____

individual programme: ___ - ___ (give date of approval)

honours programme: [Honours Programme Master]

specialisation / annotation: [Medisign]
[Tech. in Sustainable Design]
[Entrepeneurship]

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Elif Ozcan Vieira	dept. / section:	Design Aesthetics
** mentor	Samuel Kernan Freire	dept. / section:	Internet of Things
2nd mentor			
	organisation:		
	city:	country:	

comments
(optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair   Elif Ozcan Vieira   date   12 - 05 - 2023   signature

Digitally signed
by Elif Ozcan
Vieira - IO
Date: 2023.05.15
21:08:49 +02'00'

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 20   EC

Of which, taking the conditional requirements
into account, can be part of the exam programme   20   EC

(★) YES   all 1st year master courses passed

( ) NO   missing 1st year master courses are:

List of electives obtained before the third
semester without approval of the BoE

name   Robin den Braber   date   17 - 05 - 2023   signature

Robin
den
Braber

Digitaal
ondertekend
door Robin den
Braber
Datum:
2023.05.17
00:20:43 +02'00'

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: (★) APPROVED   ( ) NOT APPROVED

Procedure: (★) APPROVED   ( ) NOT APPROVED

comments

name   Monique von Morgen   date   30 - 05 - 2023   signature

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AI chatbot application in ICU digital diary
project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple.
Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date   11 - 04 - 2023   15 - 09 - 2023   end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Each year, over 30,000 patients are admitted to Erasmus Medical Centre (Erasmus MC)and they stay at Intensive Care Units (ICU) for an average of 6 to 7 days (Erasmus, 2021). Advances in critical care medicine have allowed ICU patients to save their lives, but various problems remain in improving their long-term prognosis (Inoue et al., 2019). ICU survivors have been shown to face common psychological issues during recovery, including anxiety, depression and post-traumatic stress disorder (PTSD) (Jones et al., 2010) and studies have shown that more than half of patients develop new physical, mental and/or cognitive problems after ICU stays (Geense et al., 2021). These problems are collectively called post intensive care syndrome (PICS).

Research is found that using ICU diaries in the ICU has many benefits for all stakeholders involved in the ICU. ICU diaries can help patients to understand what is happening during their ICU stay and the recovery process, thus avoiding the development of psychological problems (Brandao Barreto et al., 2021). Through the evaluation of relevant studies, it has been shown that ICU diary can reduce patients' anxiety and depression (McIlroy et al., 2019). For healthcare professionals, reading ICU diaries and interacting with patients can help them improve daily care for ICU patients and families (Haakma et al., 2022). Currently, Erasmus MC is working on the implementation of a digital diary and a customised strategy to support healthcare professionals in using the innovative ICU diary - Post-IC, which is a digital version of the diary to provide personal information to ICU patients and their families. Erasmus has recently conducted relevant research for exploring the facilitators and barriers in the implementation of Post-IC, which can help to understand the context of the current ICU diary and provide potential solutions during this project.

Chatbot, also known as intelligent agents, are prime examples of artificial intelligence systems and has potential in the healthcare field (Miner et al., 2020). On the one hand, Chatbot can process data and information efficiently and streamline the workflow of healthcare professionals. On the other hand, Chatbot can communicate closely with users and may reduce mental health symptoms, but long-term outcomes are unclear and need to be studied (Laranjo at el., 2018). Furthermore, most Chatbot is used for patients and few help healthcare professionals in their work (Xu et al., 2021). Recent technological advances have made large language models a key factor in the development of Chatbot. These models are trained to process large amounts of data and drive the shift from conversational AI to human-like experiences. OpenAI has recently released GPT4 which can accurately and fluently perform various natural language processing tasks and generate human-like text (OpenAI, 2023). How this technology can be adopted to help healthcare professionals still need to be explored in the future.

Therefore, In the context of this research, the possibilities of using an AI chatbot in combination with the current ICU diary, products and/or systems will be explored. Human-centred AI solutions could be created to support ICU patients' emotional needs more effectively and efficiently during and after ICU. The currently identified stakeholders with the main interest in this project are healthcare professionals, ICU patients, Families of ICU patients and hospitals.

This project will work with the ICU of Erasmus MC in Rotterdam, which can be helpful to get a better understanding of the context of this project and bring opportunities to conduct research with the target group and evaluate the result of this project, and TU Delft Critical Alarms Lab (CAL). CAL has relevant studies exploring AI technology in the context of ICU, such as using AI to diagnose patients' stress and using AI for the humanisation of the ICU. Based on these studies the potential of AI in the ICU will be explored deeper in this project.

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introduction (continued): space for images
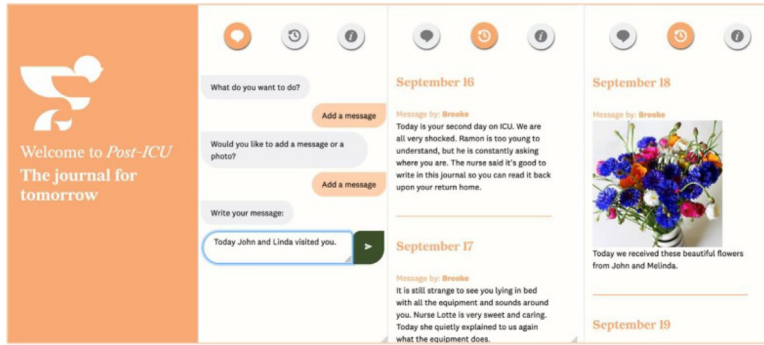
image / figure 1:   Overview of screen layout Post-ICU diary (Haakma et al., 2022)
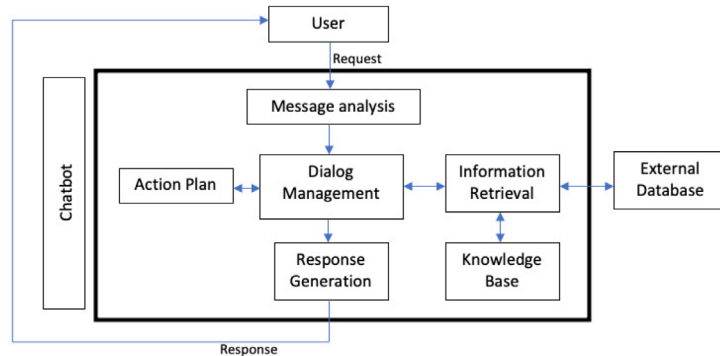
image / figure 2:   Schematic representation of general chatbot architecture (Nimavat & Champaneria, 2017)

PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Although ICU diaries have been shown to have a positive impact on healthcare professionals, there are still some barriers, including a lack of time to record and a lack of confidence in the information they record (Haakma et al., 2022), a sense of invasion of patient and family privacy and an inability to balance a high-pressure job with the development of coping strategies (Perier et al., 2013). Chatbot is not yet commonly used, but there are many opportunities, such as integrating incoming information, processing information efficiently, screening for potential cognitive impairment, providing regular feedback, and assisting healthcare professionals in developing coping strategies. Therefore, the question of how Chatbot can improve the experience of healthcare professionals using ICU diaries is an issue that this project will focus on.

Follow-up care after ICU will also need to be considered. Chatbot can act as an intermediary between healthcare professionals and ICU survivors for remote monitoring and care. As Post-IC is text-based, situations such as image recognition or voice could be considered for application in Chatbot to enhance communication between patients and healthcare professionals. How Chatbot can be integrated into current ICU diary workflow to reduce PICS will be investigated.

While Chatbot has great potential, the following aspects need to be considered when undertaking their design. Firstly, most healthcare professionals and patients lack trust in Chatbot (Palanica et al., 2019) and concerns about the technology may be alleviated as Chatbot develop, but it will take some time; secondly, healthcare data is highly sensitive and consideration should be given to the security of the data when using Chatbot (Chow & Xu, 2021).

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

This project will explore on how AI technology can improve the experience of ICU nurses using ICU diaries and can be integrated into current ICU care workflow, thus help ICU nurses support patients' emotional needs. The end result will be a product solution that apply AI technology into the Post-IC thus support ICU nurses in using the digital diary.

1. Research the current situation of ICU in Erasmus
   - The current workflow during ICU stays
      - Mapping the daily journey of ICU nurses
      - ICU nurses' daily task in using Post-IC?
      - The interaction with patients/families?
      - ICU nurses' perceptions on Post-IC
   - Follow-up procedure after ICU stays
   - Envision a product/product-service system
      - What are the needs of ICU nurses?
      - What are the design opportunities for applying AI technology?
      - Ethical consideration & medical data privacy
2. Research the technological solutions
   - Large Language Models
3. Explore the potential solutions
   - Prototyping
   - User testing & Iteration

PLANNING AND APPROACH **
Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 11 - 4 - 2023   15 - 9 - 2023 end date

	April			May				Jun.				July				Aug.				Sep.		
Date of Monday	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	4	11	18
Project Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Kick-off Meeting	4/11																							Adjustment
Background research																								
Prepare for interview																								
Interview & Observation in Erasmus																								
Journey mapping																								
Technology research existing LLM																								
Set up architecture																								
Future vision																								
Determine prototype topics																								
Prototyping																								
Mid-Term Meeting									June															
Iterate on Prototype																								
Prepare for evaluation																								
Evaluation																								
Green-light Meeting																July								
Report writing																								
Presentation Preparation																								
Graduation																							9/15	

My project will last 23 weeks, including 7 public holidays. From Week 1 to Week 3 I will be working 3 days a week as I have two electives to finish and will be working 5 days a week from Week 4 onwards. The time schedule is based on the tasks of each stage, and the specific time may be fine-tuned according to the actual situation or unexpected situation.

In the first 9 weeks of my project, I will do background research and field research to investigate the current situation of using Post-IC during ICU and after ICU, and the workflow based on the ICU diary, figuring out the pain points of healthcare professionals. The research will be conducted by literature reviews and observations in Erasmus, and interviews with ICU nurses from Erasmus. Technology research will also be conducted by relevant literature review. The future vision for the product and the basic architecture of product are expected to be set up. From Week 10 to Week 17, the structure and functions of product will be further developed by prototyping. Product will be implemented through code by using API of Large Language Models (e.g. ChatGPT) and the relevant interface will be designed.

From Week 18 to Week 23, the final evaluation is expected to be conducted to test the usability of product and get opinions from healthcare professionals in Erasmus MC. The prototype will be presented to ICU nurses. The questionnaires will be used to evaluate the final prototype. Whether this product could help nurses in the context of ICU will be figured out if possible. And then the documentations and the presentation will be finished.

MOTIVATION AND PERSONAL AMBITIONS
Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

During my study at TU Delft, I have learnt a lot and gained a better understanding of the whole design process and design methodologies. In the compulsory course AED, I chose a project of designing for burnout people to improve their experience during meditation and I have known more about healthcare knowledge for this target group. Our group have created a more intuitive tactile experience which involves 4 different patterns of vibrations regarding the different phase of burnout people. I have become more and more interested in designing for healthcare and exploring possible solutions from technological perspectives. Therefore, I would like to dive more into it through this graduation project.

During this project, I will mainly explore how to use advanced technology to solve the problem in the context of healthcare, bridging the gap between the technological and the medical field.. The user experience will also be considered to achieve the final solution from the perspective of feasibility, viability and desirability to fit the needs of the target group.

Competences I want to learn from this project:
- Dive into AI technology and explore the potential solutions to bridge the gap between technology and the healthcare field.
- Gain better project management and planning.
- Obtain more experience in AI technology and how to implement it into the design.

FINAL COMMENTS
In case your project brief needs final comments, please add any information you think is relevant.

02 Observation plan

Observation Checklist

Purpose

To gain a general knowledge of the ICU environment and to experience the context of the ICU.

Necessities

- two notebooks:
    - answers to research questions
    - insights not relating to research questions
- a camera to take pictures

General knowledge ICU

- What is the average stay of an ICU patient?
- Who is involved in an ICU team?
- When do these people interact?
- How do these people interact?

The daily task of an ICU nurse

- General task?
- Touchpoints?
- ICU diary? Handwriting or digital?
- Who will be involved in writing the diary?
- When do nurses write the diary?
- How do nurses write the diary? (text and pictures)
- When do nurses interact with relatives?
- How do nurses interact with relatives?
- Follow-up care process after patients come back home

03Informed consent for interview

Informed Consent for semi-structured interview

You are being invited to participate in a research study titled "Explore the possibilities of ChatGPT for the digital diary in the context of ICU". This study is being done by Kaixin Tang from the TU Delft for a master graduation project. The purpose of this research study is to design an application that visualising the patient information in the current workflow, reminding nurses to complete the diary and provide a ChatGPT-based solution to support them in writing the diary.

In this interview, I will ask you some opening questions according to your using experience with my design. This semi-structured interview will take you approximately 30 minutes to complete. The data will be used to analyse and then improve my design.

We assure you that your answers in this study will remain confidential. We will collect your job title, job sector or education background, and user behaviour to analyse different user journeys. To minimize any risks, we will ensure that the analysis result of this survey is entirely anonymous, and no IP addresses or other Personal Data will appear. All the data collected will be stored safely, and confidentiality will be secured by anonymising the data.

Your participation in this is entirely voluntary, and you can withdraw at any time. You are free to omit any questions. If you have any questions or concerns regarding this study, please feel free to contact the corresponding and Responsible Researcher, Kaixin Tang at K.Tang-5@student.tudelft.nl. Thank you for your participant in this study!

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated __ /__ /____, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves participating in the semi-structured audio-recorded interview. I also understand that the video will be transcript into text. The audio will be stored securely and anonymously for a maximum of 6 months, after which it will be destroyed.	☐	☐
4. I understand that I will be compensated for my participation in this study.	☐	☐
5. I understand that the interview will end in approximately 30 minutes.		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves collecting specific personally identifiable information (PII), such as my name, email address, and associated personally identifiable research data (PIRD), such as job title and sector.	☐	☐
7. I understand that the following steps will be taked to minimize the threat of a data breach, and protect my identity in the event of such a breach: - All the audio will be transcript into text. - All the audio will be stored securely and anonymously in TU Delft Project Data Storage.	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
- All the audio will be destroyed after 6 months.		
8. I understand that personal information collected about me that can identify me, such as my name, sector, job title, and user behaviour will not be shared beyond the study team.	☐	☐
9. I understand that the (identifiable) personal data I provide will be destroyed after the research is finished.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
10. I understand that after the research study the de-identified information I provide will be used for the reference of design outputs and master thesis.	☐	☐
11. I agree that my responses, views or other input can be quoted anonymously in research outputs.	☐	☐

Signatures

_____   _____   _____
Name of participant [printed]   Signature   Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____Kaixin Tang_____   _____   12.09.2023
Researcher name [printed]   Signature   Date

Study contact details for further information: Kaixin Tang, K.Tang-5@student.tudelft.nl

04 Nurse interview transcripts

Nurse interview transcript

semi-structured Interview question:
- What are the daily tasks of a nurse in a day?
- When do you usually work on the diary in a day? And how much time do you spend on the diary?
- What kind of information do you write in the diary?
- How do you communicate with families? When do you usually meet them?
- What kind of information do families want to know from nurses?
- How do you offer the diary to families?
- Do ICU nurses and families be involved in the process of using the diary?

Interviewee 1:

Q: How many patients should a nurse be responsible for?
A: Each nurse is responsible for 1-2 patients and they are also responsible for patients' report which is about the medical information of patients. For a team, the number of patients might vary according to the time. In the morning each nurse is responsible for 1.5 patients and in the afternoon it is 1.75. During the night they are in charge of 2 patients. But they do not have overlapping patients. They have their own patients.

Q: How often do you interact with other nurses?
A: We have 3 shifts in a day. We shifted at 7:45 in the morning, 15:00 in the evening. During the first 15 minutes of the shifts, we will read the patient's report to gain medical information about the patient.

Q: How do you communicate with families? When do you usually meet them?
A: We have visit time to meet with families if they come to ICU. The meeting time is 11 in the morning. If they cannot come, we can communicate with them on the phone. But not everyone can meet with nurses. Only two people from families can contact a nurse.

Q: You mention that each nurse is responsible for the patient's report. Is it a medical or non-medical report?
A: No we only write the medical report. It is about the patient's treatment, medical characteristics and stuff like that. But we offer the non-medical diary to families and they can write everything down in the diary.

Q: How long do spend on the medical report?
A: It takes 5 min to write the report because lots of medical information are already documented in the file and it won't take too much time to write the report. So I will finish the report outside the patient room during my free time. We do not have a fixed time to finish because it only takes 5 minutes. so if you do not need to do checks or meditation in the patient room, you can work on it.

Q: How do you offer the non-medical diary to families? When do you offer it?

A: It should be offered at the beginning of patients' ICU stays. But most of the time I forgot to offer it to families. If families ask about it I will offer or if patients are in a terrible situation and they do still not wake up, it might remind me to offer the diary to families. It is very random.

Q: Do ICU nurses and families be involved in the process of using a non-medical diary?
A: No we just offer to the families and they are in charge of the diary. They can write daily information about patients. We do not write the diary and read the diary because I think it should be written by families instead of nurses. We can report the medical part of the patient but it is better for families to work on the non-medical part. And the content of the diary is private and it is the privacy of the patient so I would not read it. But we share some non-medical information during the visit time. For instance, the patient slept well yesterday. Families can ask the question and then we will answer their questions. Most of families care about the sleep situation and recovery.

Interviewee 2:

Q: How many patients should a nurse be responsible for?
A: 1-2 patients every day.

Q: How often do you interact with other nurses?
A: I work during the day, in the evening and in the weekends. I don't work in the night shift. We have three shifts in a day. There are 7:45 and 15:00 on weekdays and weekends.

Q: How long do you spend on the medical report?
A: it depends. Could be 5 mins. Could be 15 mins. If I know the patient, it would be short. But if it is a new patient for me and it is complex, I need more time. It could be more than 15 mins but not normal. It depends on the patient's situation.

Q: How do you communicate with families? When do you usually meet them?
A: mostly when they arrive, I will go in to have the conversation. I am telling about patients. Mostly, in the morning about 10 people will call us and they want to know what the doctor said and I tell them. We speak to families every day. In the evening, people are at home and they call us before sleep. and they ask how are things going and I explain to them.

Q: The report nurses work on is related to the medical part of patients. What about the social part of patients?
A: There is a sign in the patient's room. (showing the board in the room) families can write down patients' personal information, like what kind of music they like. Mostly it is written by families and nurses can read it so that they can know more about patients. every room has a sign.

Q: What kind of information do families want to know?
A: Mostly they ask the questions and then we tell them. Did he/she have a good sleep? Will you turn on the television tonight for the soccer game? They care about the patient's sleep situation and entertainment like TV, music or video.

Q: How about the non-medical diary?
A: We offer the diary to families. And the families will write. but we do not write mostly. It is not the daily task of nurses and it is for families. I do not do it. Families can write down the things in the diary and when the patient is awake or at home, you can read the diary. so you can read how is the situation in the ICU.

Q: Why nurses are not involved in the process of the diary? Is this because of the workload?
A: No, not for the diary. If I need to write, I don't know what to write in the book. If I need to say something to my patients, I tell them today like what do you do. I can tell families but I don't write it down. And I don't read it. It feels a little private.

Q: When do you need to offer the diary?
A: mostly, the families can ask for it. They heard about it and they sign. sometimes the nurse gives it to families.

Interviewee 3:

Q: How many patients should a nurse be responsible for?
A: 1. Sometimes 2.

Q: how long do you spend on the medical report?
A: mostly in 5 to 10 mins. I think if I can concentrate it could be 5 mins. only the writing of report.

Q: What is the content of the report?
A: it's mostly medical. so you write something about medical characteristics. and also you can write something about patient's daily task like pooping, sleeping. And you can write their feeling if the patient can say something.

Q: When do you usually talk with the families?
A: If the family is there, I will talk to them. And sometimes I talk to them by telephone. Just in visiting hours. It's 11-2 and 4 until 8 in the evening. And outside the time, people can call us in the evening, in the night, no matter what. The calling time is flexible but we always ask not to call when we are talking to the next shift, so the shift is about 7:30, 3:00 and 11 in the evening. So we can focus on the report for the next shift. but after that, they can call always.

Q: When do you usually work on the report?
A: Mostly at the end of my shift. so I can write everything in a day.

Q: How do offer the diary to the families?
A: we should do it with patients that come here but we forget it a lot of times. sometimes when the patient is very sick and it happens a lot, then I ask families if they already have the diary. Otherwise, I might forget it. It should be offered at the beginning when they come here.

Q: It sounds like offering the diary is not in a high priority.

A: No because sometimes you don't know how long the patient will stay. If the patient stay for about two days, it is not necessary to offer the diary. But if the patient stay for few days or weeks then it is nice to have the diary. Some colleagues are good at it, they do it directly. but mostly it is not happening. so sometimes you see the family members and they don't know everything because there are so much information that are offered to them.

Q: Do you need to spend much time explaining the diary to families?
A: No. In the diary, there are a lot of information explaining about the hospitals and visiting time. so I always said that they can read by themselves at home and I explained that there are few pages that families can write by themselves.

Q: Do they share diary with you?
A: No. Mostly they don't tell about what they write. Sometimes they left the diary in the patient room and it is open, I can read. But it is not they share with me what they write. some people take it at home and they write. some families left it here and write it at here. but we don't read it because I think it is a little bit private for families.

Q: Do you need to know more about personal information of patients?
A: personally I always ask information about patients from families so I would ask things if I don't know yet. and I would write information that I think it is important in the medical report. but if you have few days later, you have to scroll down in other report write sometimes information get loss if someone is lying here in a longer time.

Q: Do nurses be involved in the process of using the diary?
A: No I do not write the diary. I only write in the medical report. if there is a family member here, I would tell them what happened. but I do not write it in the diary. so they have to write by themselves. Because the diary is for the families not for us. And it is not in our system. I always tell family members they have to write it every day but we are telling what happened. Because it has a lot of information. For now the diary is their responsibility. So I would say write down what happen, take some pictures of patients. because sometimes information we give is too much. so if we tell the patients something about a scan or plot work, they don't understand it. so I think if we write it down in the diary, they gain too much information and they don't understand it. And they are writing it down in their own words. So maybe I said I've seen the plot and that's not good and the family member write down, not too many details.

A: Nurses can be involved in the process of the diary. But then it has to be some rules for everybody that what to write down because I can write down very specific info but the info the family and patients do not understand it. So you have to tell them in an easy way. Sometimes it is a little bit difficult. Then I think what I said is understandable but sometimes they do not understand. maybe because they are in high emotion and they cannot listen to bad news.

Q: How do you communicate with families?
A: I talk to them in the room. Sometimes we plan time with the doctor. So I tell them and I ask them if they can understand me. If they don't understand I would repeat in a simple way. But sometimes you think you explained clearly and after they did not understand. Some people do but always but not everyone. half-half.

Interviewee 4:

Q: How many patients do you need to take care of in a day?
A: It is max to 2 patients. 1 or 2 patients. when you have night shift, you have 2 patients. in the evening it is 1 or 2 patients.

Q: the current workflow?
A: in the morning we take care of the patients with washing, toothbrushing, shaving, wash hair and stuff like that, like personal care. then we visit the doctors, talk about the things we will do today, such as meditation. sometimes the patient need to get out of the bed. we do every 2 hours to validate the numbers, and temperature to observe. And we need to check if the patient is okay. And maybe some other specialist will come. And it is about the same in the evening. We talk to the families and give them updates. In the nighttime, patients need to turn on the other side every 4 hours. But if that is too long, we will do it every 3 hours. It depends on the situation of patients. If the patients are very sick, they cannot often move.

Q: how do you communicate with families? How long do you meet with them?
A: It depends on how many questions do family want to ask. For example, if you already worked with the same patient for a few days, the families will not ask too many questions. But if there is a new patient, the family will have more questions. So it depends on how many information you need to offer and how many questions they have or how situation the patient is. And sometimes it took a few minutes and sometimes a couple of hours.

Q: what kind of information do they want to know? / what information you will offer to the families?
A: they want to know how was it going. for example, if the patient is ill or has fever, they want to know how is it going with the infection. or some people ask how long do they need to be here, is it going worse or well, how is it going. Because there are many patients sleeping so they do not have contact with families. so they ask how is it going with everything like is the patient gets better. If somebody is sleeping, they will ask do you know how long he/she will be sleepy.

Q: When do you usually meet families?
A: The visiting hours are between 11 and 2 in the morning and between 4 until 8 in the afternoon. and sometimes when the patient is admitted, then families comes outside the visiting time. Sometimes they will call us on the phone and ask how did the night, how did she sleep well. So we also talk with them on the phone.

Q: how do you offer the diary to families and when?
A: When you think the patient just stay for few days, you don't offer diary. When it is clear that the patient will be here for a longer time, you need to offer diary. But we should give the diary when the patient is admitted. So the patient comes here and the family will arrive later. And we admitted the patient and speak to the family and then normally we offer the diary. But we forget it and it does not happen. and in a few days, we explained to them how to use the package. It is not only about the diary. It also includes some flyers that are about parking and other things.

Q: After offering the diary, do nurses be involved in the diary?
A: No. We don't do that here. If the families want it, we can write something in the diary. But normally we don't use it. The families use it by themselves and when the patients wake up they can read it to fill in the blank of their memory.

We do not have a system that has a diary check. If it can be checked, it could be better.

Q: what do you think of the board about personal information?
A: I think it is helpful because we get an image of what the patient is like. It makes patients more human-like. we can know the hobbies of patients. For example, if we know what kind of music they like, we can turn on the radio and play their favourite music. Some patients will be better with less emotion, and less sadness. Also, you can easily start the conversation with patients if they wake up.

Q: When do you interact with patients?
A: Through the day. It doesn't matter what the time is. Some patients like to listen to relaxing music at night so that they won't be anxious. It has no fixed time. It is flexible. we will also get advice from families. Or they can also play their own music.

Q: If the nurses are involved in the diary, what is your opinion?
A: I don't have a strong opinion about it because I think the mental part is also part of our job. But it is the mental part after ICU. So I think when families write it and they ask us and then they write it, it is also okay. It doesn't matter it is written by families or nurses. But if the families are in high emotion, it is hard to write. in that case, we can write some short paragraphs. or we can write some details. But I think what I write may not be important for patients. Write the information they think is important could be better. Every patient has their main focus when they are reading the diary. I don't know what they want me to write. I think the families can make an estimation that what the patient might want to know after ICU and then we can write based on the estimation. They can give us some guidelines for writing the diary. I also recommend to make some pictures because it can help patient know more about their recovery process. I mean the patients can make a choice whether they want to see the pictures or not. If some people don't want to see pictures, they can also choose not to see. If you have the choice, you can make a choice by yourselves. So I do recommend to make pictures and also to write the diary.

For the current package of diaries, families can choose how to write and what to write. They can write something and they can take pictures and then stick in the diary. Or they even can draw something in the diary. It's up to families.

Interviewee 5:

Q: how many patients do you need to take care of?
A: 1 or 2 is normal and sometimes 3 patients but it is really rare.

Q: What are your daily tasks in a day?

A: in the morning we start at the television board by other patients and then divided everything and then we changed from the night shift to morning shift. and you can read some report about patient in the system. after that you wash everybody sheet. After lunch, you don't have too much tasks so you just wait. families come and visit and update them. they ask questions.

Q: what kind of questions do they ask?
A: How is it going? is there any improvement? some people ask about the infection, but not too much. some people visit every day but some don't. It depends on the families.

Q: about using the diary.
A: I don't use this diary. I tell families to write this diary and make pictures so that if patients wake up they can tell patients what happened.

Q: When to offer diary?
A: Never do that before. I always forgot it in the beginning. after a few days I remembered but my colleague already did that. and some families takes their own diaries and so I do not need to offer anything. It is not a structure every patient gets the diary because I think it is a waste of money if some patient comes here for like one night and then they leave. It is not necessary to give them the diary. and sometimes people come here and we don't know how long they will stay. If I get a new patient, giving the diary is not on top of my list and I just forget it.

It is not in the process in the current workflow. you have to think about it and remember about it. We never put this diary in the room. somebody has to think about it. otherwise, nobody can remember it.

Q: Personal information board
A: the board helps me to know about the patients like their names, hobbies and what they wanna hear. So I do always ask family if they are here. I asked them to fill it in and most of time they do. If somebody wake up, we can start conversation with them. the board is nice and it is really helpful. It feels like the patient is not just a patient but also a person.

Q: If the nurse is involved in the process of using the diary, what's your opinion?
A: It is the responsibility of the nurse but it needs to get more into our system that we had if we got new patients because it is not in our system. So if it gets into the current workflow/systems and then more people can get the diaries.

Q: system?
A: the diary needs to be in collaboration with the current system.

05 Informed consent for evaluation

Informed Consent for the evaluation

We invite you to participate in a research study, "Explore the possibilities of ChatGPT for the digital diary in the context of ICU," conducted by Kaixin Tang from TU Delft's IDE. The purpose of this research study is to design an application that visualising the patient information in the current workflow, reminding nurses to complete the diary and provide a ChatGPT-based solution to support them in writing the diary.

Your participation involves experience two different applications, answering questionnaires based on your experience and joining a semi-structured interview to share your thoughts regarding the design. This will take approximately **45 minutes**. The collected data will be used to analyse the design's usability and user experience.

We assure confidentiality and anonymity in handling your data, which includes your gender, education background, and user behaviour. No personal data such as IP addresses will be visible in the analysis results. All data will be securely stored and anonymized.

Your participation in this is entirely voluntary, and you can withdraw at any time. If you have any questions or concerns regarding this study, please contact Kaixin Tang at K.Tang-5@student.tudelft.nl. Thank you for your participant in this study.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated __ /__ /____, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves participating in the semi-structured audio-recorded interview. I also understand that the video will be transcript into text. The audio will be stored securely and anonymously for a maximum of 6 months, after which it will be destroyed.	☐	☐
4. I understand that I will be compensated for my participation in this study.	☐	☐
5. I understand that the interview will end in approximately 45 minutes.		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves collecting specific personally identifiable information (PII), such as my name, email address, and associated personally identifiable research data (PIRD), such as job title and sector.	☐	☐
7. I understand that the following steps will be taked to minimize the threat of a data breach, and protect my identity in the event of such a breach: - All the audio will be transcript into text. - All the audio will be stored securely and anonymously in TU Delft Project Data Storage. - All the audio will be destroyed after 6 months.	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
8. I understand that personal information collected about me that can identify me, such as my gender, education background, and user behaviour will not be shared beyond the study team.	☐	☐
9. I understand that the (identifiable) personal data I provide will be destroyed after the research is finished.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
10. I understand that after the research study the de-identified information I provide will be used for the reference of design outputs and master thesis.	☐	☐
11. I agree that my responses, views or other input can be quoted anonymously in research outputs.	☐	☐

Signatures

_____   _____   _____
Name of participant [printed]   Signature   Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____Kaixin Tang_____   _____Kaixin Tang_____   ____09.10.2023____
Researcher name [printed]   Signature   Date

Study contact details for further information: Kaixin Tang, K.Tang-5@student.tudelft.nl

06 Evaluation - user testing notes

User testing Notes

- The recommended diary theme is helpful and intuitive, which can give me an overview of what I should write in the patient diary as a nurse.
- At first, I was confused about adding a new patient's diary and did not notice the Add Messages section. Maybe it is nice to change "Add a new patient's diary" to "Add another patient's diary".
- The tracker seems a little bit confusing. I did not know what it was for and was doubtful about the status of the checkbox. Does it update every day or every week? It is not clear to me.

- The layout and the colour are clear and intuitive to me. As a non-experience user, I think it saves my time and I can know what it was for in a short time.
- The interface and the interactions are smooth and comfortable compared to the Post-ICU diary. I personally do not like the conversational assistant since it has too many steps to follow and I think nurses do not have much time to deal with that.
- Compared to the Post-ICU Diary, it has clear and useful functions, and I see the potential in the ChatGPT-based assistant.

- In the Post-ICU diary, I have to add text and photos separately. But in the Patient diary toolkit, the diary entry layout allows me to add text and photos together, and it also includes some information that the Post-ICU Diary does not include.
- When reviewing the patient diary, it is easy for me in the Post-ICU Diary since the interface is quite simple. In the Patient Diary Toolkit, I like the different colours and icons to distinguish the diary entry which the Post-ICU Diary does not have.

- I think the dashboard view still has some improvements. The recommended diary theme could be presented first as a thumbnail and then the whole detailed description could be shown if the user wants to see it. The tracker could be presented as a calendar instead of in a week or a day. It will show what date of the diary entry has already been finished. Users can click on and then jump to the page of reading the diary or adding messages, which I think is more convenient and intuitive.
- I personally like the way you add a message in the diary instead of talking to the system and following step by step. It saves a lot of time and it streamlines the process of adding a message in the diary.
- I think the suggestion in the Post-ICU Diary is quite confusing for me. I cannot ask questions by myself. Only I can do is just follow the step and sometimes the

suggestions it provides is not relevant to the scenarios, which is quite annoying and time-wasting. In another application, I could start a chat with the ChatGPT assistant, whether to use the prompt templates or to start by myself, which gives me a possible way to choose and the responses seem to be more relevant to my scenarios.

- I think data privacy should be considered when you are using the ChatGPT assistant because some patients and families do not want to share their personal information but sometimes you have to provide some info in the ChatGPT to ensure the accuracy of the responses.
- The responses from ChatGPT seem too long and I would not read all of them if I were a nurse and I still need to do a lot of medical measures. I would probably read the keywords and then start my diary writing.

- The whole interface is quite clear and intuitive compared to the Post-ICU Diary.
- I was confused when reviewing the patient diary. At first, I did not realise that I could scroll the interface and then review the rest of the patient diary. And I did not realise there were two different patient diaries on the same page. It is nice to tell the interactions more directly, such as adding a bookmark or adding a slider.
- I did not figure out how to add a message to the patient diary because the interface seems to be the same as the one on the existing diary page. If I do not hover the interface I would not know how to add a message. It is not logical for me.
- The ChatGPT assistant is not visible as I thought it was a part of the diary entry layout and I did not realise I could click on it to start a conversation with it.
- Does the assistant keep the history conversation if I change to the other functions? It is not clear to me.
- You have to use these 3 functions in different conversations. Although you can use the 'prompt' to change among them, the process of using the assistant is still complicated for me.
- As a nurse with less experience with ChatGPT, the functions of prompt templates and how I can use them are not clear to me.
- I would not totally trust the responses from ChatGPT since it is not always trustworthy. How can you deal with this problem?

- I expect ChatGPT to provide an example instead of giving a lot of suggestions. I would not read all the text from ChatGPT. I would just copy the example of the diary entry and then revise it by myself. I think it is more convenient.
- The trust issues of ChatGPT should be considered since you cannot just adopt the results from it. You still have to check it by yourself.

- I did not realise the ChatGPT assistant as it seems like a background of the interface and it does not have a pop-up to guide you.

- It is more logical if the ChatGPT assistant can be a separate section instead of being included in the Add Messages section.

- The layout of each diary entry in the existing patient diary is more intuitive.
- The ChatGPT assistant is not visible.
- Using the prompt templates all the time might get similar answers, which may not be helpful for nurses especially when they have experience with digital diary writing. So it is considerable to think about the further development of the ChatGPT assistant.
- The weekly completion is a little bit confusing and sometimes it is not practical. For example, if you just finish one patient diary instead of both patient diaries, you can also click on the checkbox. So why not just track each patient's diary for a week?
- The recommended diary theme section seems to be redundant. The recommended diary theme can be provided in the ChatGPT assistant. Nurses can choose one of the subjects and then the assistant could provide suggestions based on the subjects they choose. Also, there are too many texts to read as nurses do not have much time to go through all of them. If I were a nurse, I would just open the diary and then add a message, and ask the assistant to help with my diary writing.

- I think the process of adding a message could be streamlined. For example, you can choose which one you would like to add in the diary entry layout instead of choosing the patient's diary and then adding a message.
- I think the conversational way is more interesting than just filling in some information in the diary entry layout.
- I need to spend some time reading the text from GPT which is kind of time-wasting.
- Why not just let me choose the topic, patient situation and my working shift? I think it is more efficient and convenient than revising the templates and then sending them. I could tell the assistant by choosing the corresponding buttons and then the assistant can reply to me.

- The size of the characters should be adjusted. It is not readable.
- I personally think the flow is too complicated. I need more steps to finish the tasks, which increases my cognitive burden and time burden.

- It would be more logical if the system could monitor whether the nurses finish the daily diary entry instead of clicking on the checkbox by the nurses themselves.

- I like the recommended diary theme section. It is clear and intuitive to me because I could easily know what I can write in the patient diary. And it can jump to the Add Messages section by just clicking on the icon.
- I did not realise that Add Messages is a part of the Patient diary module. I think it would be nice if I could directly see the diary entry layout and choose which patient diary in the layout.
- "Send" button -> "Add" button
- You cannot totally trust the answer from the GPT. The answers from GPT are sometimes very templated and it is still necessary to modify the text by nurses. Is it a time burden and effort burden for nurses?
- The responses from GPT would be similar every time you use the template. The templates would be helpful for non-experience nurses. But if they are familiar with the working process of diary writing and they already know how GPT can help them, will GPT still contribute to their diary writing?
- At first time I did not notice the GPT logo. If the nurses are not familiar with GPT they would not probably know they can interact with it.

- The logging process is quite intuitive. But the icon of the dashboard is not clear to me cuz I cannot quite make sure it is the dashboard.
- Most of my attention was drawn to the Recommended Diary Theme section. There are many texts to read, so at first, I spent some time reading this part, figuring out what this section is used for.
- The process of adding messages is quite easy in the Post-ICU Diary. While in the Patient Diary Toolkit, you can add messages through the patient diary section or the daily diary check, which is convenient. But I personally prefer adding messages directly in the existing diary cuz it is logical for me.
- I think the layer of these two apps is quite different. The Post-ICU Diary, allows you to add messages at first and then read the existing diary. While the Patient Diary Toolkit allows you to read the diary and then add messages. If I were a nurse, I would prefer to write firstly cuz it is part of my job and then read the diary if I have enough time.
- The assistant is not visible. Maybe it is better to add a notification or a pop-up to remind users.
- I do like the 3 functions. It is clear and it is practical for diary writing.
- It would be better if the history of the conversation could be kept so that I could review it anytime.
- In the Dashboard view, you could consider combining the login/out function with the account.
- For function, the template provides a more comprehensive way to improve the accuracy of the responses, which makes this design more professional. For the user experience, the process of using this application is easy to understand, which makes this design general.

07 Questionnaires for comparative testing

Task 1 - Diary review

☁

Post-ICU Diary

Please provide your impressions of the **Post-ICU Diary** you have tested with task 1 by check marking your impression on the scale between the terms offered in each line.

*

	1	2	3	4	5	6	7	
Cumbersome	○	○	○	○	○	○	○	Straightforward

*

	1	2	3	4	5	6	7	
Confusing	○	○	○	○	○	○	○	Clear

*

	1	2	3	4	5	6	7	
Impractical	○	○	○	○	○	○	○	Practical

*

	1	2	3	4	5	6	7	
Difficult	○	○	○	○	○	○	○	Easy

While carrying out the task 1, I felt *

	1	2	3	4	5	6	7	
Insecure	○	○	○	○	○	○	○	Confident

While carrying out the task 1, I felt *

	1	2	3	4	5	6	7	
Uncomfortable	○	○	○	○	○	○	○	Comfortable

Task 1 - Diary review

☁

Patient Diary Toolkit

Please provide your impressions of the **Patient Diary Toolkit** you have tested by check marking your impression on the scale between the terms offered in each line.

*

	1	2	3	4	5	6	7	
Cumbersome	○	○	○	○	○	○	○	Straightforward

*

	1	2	3	4	5	6	7	
Confusing	○	○	○	○	○	○	○	Clear

*

	1	2	3	4	5	6	7	
Impractical	○	○	○	○	○	○	○	Practical

*

	1	2	3	4	5	6	7	
Difficult	○	○	○	○	○	○	○	Easy

While carrying out the task 1, I felt *

	1	2	3	4	5	6	7	
Insecure	○	○	○	○	○	○	○	Confident

While carrying out the task 1, I felt *

	1	2	3	4	5	6	7	
Uncomfortable	○	○	○	○	○	○	○	Comfortable

08 Final questionnaire

Final Questionnaire

This part is to measure the usability and experience regarding the Patient Diary Toolkit. Please rate the application based on your whole experience with it.

Participant number *

您的回答

Please enter what you consider the most appropriate description for **Patient Diary Toolkit**. *

	1	2	3	4	5	6	7	
Traditional	○	○	○	○	○	○	○	Innovative

*

	1	2	3	4	5	6	7	
Bad	○	○	○	○	○	○	○	Good

*

	1	2	3	4	5	6	7	
Distant	○	○	○	○	○	○	○	Inviting

*

	1	2	3	4	5	6	7	
Ugly	○	○	○	○	○	○	○	Attractive

*

	1	2	3	4	5	6	7	
Unprofessional	○	○	○	○	○	○	○	Professional

*

	1	2	3	4	5	6	7	
Uncomfortable	○	○	○	○	○	○	○	Comfortable

Please rate your level of agreement with each of the following statements: *

	1 - I fully disagree	2	3	4	5	6	7 - I fully agree
All aspects were understandable	○	○	○	○	○	○	○
All aspects were distinguishable	○	○	○	○	○	○	○
It was clear where I could find everything and know the functions of each section	○	○	○	○	○	○	○
My general experience with the application was good	○	○	○	○	○	○	○
I think this application has future potential	○	○	○	○	○	○	○

Do you have any comments about this application?

您的回答