August 2021 | Master Thesis

Appendix

Appendix 1 | Project Brief
Appendix 2 | Questionnaire design
Appendix 3 | Questionnaire result

Author:
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Chair:
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Mentor:
Himanshu Verma

Hospital Supervisor:
Jasper van Bommel *(Erasmus MC)*

Appendix 1 Project Brief

DESIGN FOR our future

TU Delft

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: Du
initials: F — given name: Fei
student number:
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):
IDE master(s): ( ) IPD ( ) DfI (★) 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: Himanshu Verma — dept. / section: Human-Centred Artificial Intelligence
2nd mentor: Jasper van Bommel, MD, PhD
organisation: Department of Adult ICU, Erasmus Medical Center
city: — country: NL
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.

TU Delft

Personal Project Brief - IDE Master Graduation

Roadmap for an AI-based information system to help health professionals diagnose patients' stress in ICU
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 01 - 03 - 2021 — 23 - 07 - 2021 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, ...).

Every year, more than four thousand patients are treated in the ICU of Erasmus MC (Erasmus MC, 2020). ICU is a highly stressful environment for patients who are treated in a life-threatening situation. Stressors can be lack of natural light, disruption of sleep-wake patterns, absence of clocks, lack of contact with family and friends and the several clinical procedures that cause patients to experience different types of physical and psychological discomfort (Dias, Resende, & Diniz, 2015). Also, ICU is a physically and emotionally challenging environment for the interprofessional teams, comprising of physicians or intensivists, clinical pharmacists, respiratory therapists, dieticians, bedside nurses, clinical psychologists, and clinicians-in-training (Ervin, Kahn, Cohen, & Weingart, 2018). Besides, families of patients are suffering a lot during ICU treatment. The Erasmus MC provides a platform called IC Connect to helps patients and relatives go through intense time during or after an intensive care unit (Erasmus MC, 2021).

During intensive care treatment, the ventilator, dialysis machine, heart / lung machine, brain pressure measurement and monitor are used. A patient often receives thin tubes, IVs or catheters at various places in the body, and different patches and cables from different devices are sticked to the patient (Erasmus MC, 2020). Thus, the patient data can be recorded to help health professionals make decisions. The intensive Care Information System (ICIS) is widely used in ICU to record patient data. The advantages of ICIS lie in electronic documentation and automated reporting, patient data management, improving practitioners' satisfaction, evaluating quality of care, increasing cost effectiveness, time saving, decision supporting and improving researches (Ehteshami et, al., 2013). However, the potential use of patient data has not been explored from the prespectives of better care provision and patient wellbeing.

This project is a joint work of ICU in the Erasmus Medical Centre (Erasmus MC) and TU Delft Critical Alarms Lab (CAL). This project aims to design a roadmap for an AI-based information system to help health professionals diagnose patients' stress in ICU.

Due to the covid-19 epidemic, I can't visit the Erasmus MC. The collaboration with Erasmus MC will be mostly online. But I have personal contact with a Chinese hospital called Jincheng People Hospital that I can visit, so I can get a physical experience in ICU and translate the insights to better understand the context of ICU in Erasmus MC.

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introduction (continued): space for images

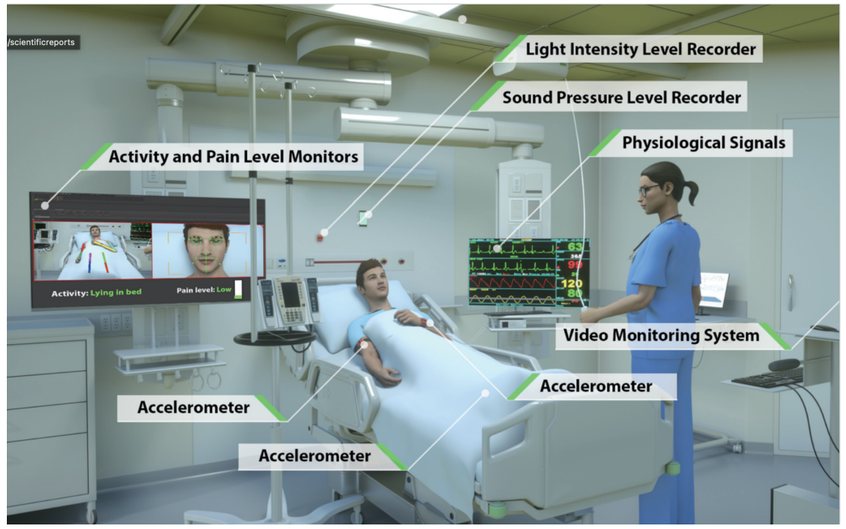


image / figure 1: Intelligent ICU uses pervasive sensing for collecting data on patients and their environment (Davoudi et al., 2019).

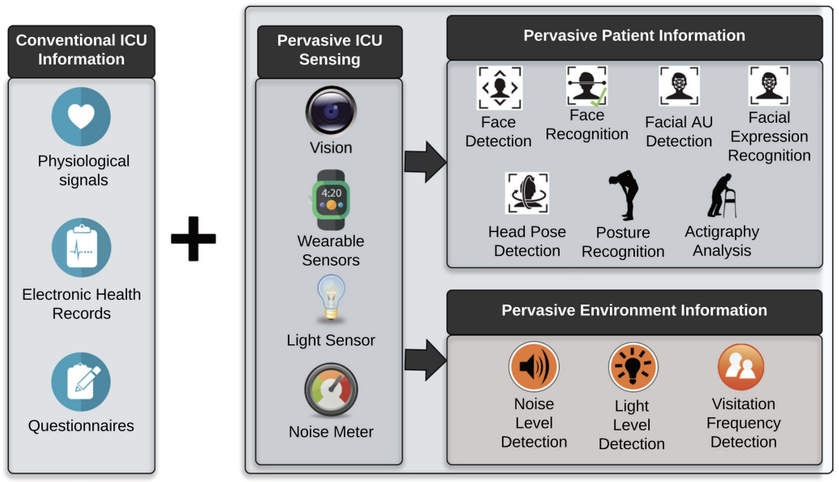


image / figure 2: Conventional ICU infromation and pervasive ICU sensing can generate pervasive patient and environment information (Davoudi et al., 2019).

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 the introduction of AI in ICU is in the initial stage, there are numerous opportunities including the length of stay prediction, ICU mortality prediction, complications and risk stratification and adaptive mechanical ventilation (Gutierrez, 2020). However, AI requires integrated and well-structured data, but a wealth of data are not yet captured autonomously such as environmental factors that result in sleep disruption and ICU delirium, facial expressions of emotional states, mobility and functional status and the assessment of patients' response to therapy and illness (Davoudi et al., 2019).

Previous research shows AI can detect patients' emotion. In a pilot study, the feasibility of a low-cost (< $300 per ICU room) pervasive monitoring system has been tested in ICU, which can potentially be used for facial expression pattern recognition and activity detection (see Figure 1 & 2). The modifiable environment stressors such as noise and light can also be quantified (Davoudi et al., 2019).

In my project, the focus lies in how AI can help health professionals diagnose patients' stress in the ICU. Although AI has great potential in ICU, several aspects should be considered before application. First, The healthcare system matters more on reliability rather than novelty, so it may take a long time for the hospital to accept the AI system. Second, the AI system should be consistent with real-world clinical utility, efficiency, existing workflows and national standards and should be validated by prospective studies before widespread implementation. Also, it should involve opinions from different perspectives of stakeholders. Data security and patient privacy. Third, data security and patient privacy should be thought through because healthcare data are sensitive (Lovejoy & Maruthappu, 2019).

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.

The goal of my graduation project is to design a roadmap for Erasmus to build an AI-based information system to help health professionals diagnose patients' stress in the ICU.

1. Investigate the current situation of ICU in Erasmus
   - What are the stressors in ICU?
   - How do stressors influence patients' health?
   - How to make personas out of patients?
   - How do HPs deal with the stressors for now?
   - What is the existing data infrastructure?
   - How to envision an AI-based information system to diagnose patients' stress in ICU?
     - What kinds of data are needed?
     - What kinds of sensors are needed to collect data?
     - How to analyse the data and diagnose the stress?
2. Explore new possibilities for practical AI applications
   - What are the cutting-edge technologies and practices?
   - How can the system be adaptive for different personas?
   - How long will it take for Erasmus to implement the new possibilities?
3. Design a roadmap for an AI-based information system to reduce patients' stress

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 01 - 03 - 2021 — 23 - 07 - 2021 end date

	Mar.				Apr.				May					Jun.				July				Aug.			
Date of Monday	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23
Project week	1	2	3	4	5	6	7	8	9	10	Break	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Stage	Kick-off							Midterm									Green Light				Graduation	(in case of adjustment)			
Actions to take	Agree on the project brief, and agree on roles, responsibilities, process, and expectations with stakeholders. **Get the project brief signed** by the chair. **Schedule important meetings** with chair and mentor Prepare for the midterm, **finish midterm evaluation form**. Hand-in prior to the meeting. Discuss feedback given by the mentor and chair. Adapt to the outcomes of the meeting (Continue, Adjust or Discontinue). **Submit signed midterm evaluation form** to Brightspace.								**Request accomplishment master courses declaration** 1 week prior to green light meeting and **send 80% version of the final thesis** to supervisors. **Present the project** and discuss feedback with the supervisors. If Green Light is provided: **confirm graduation date, agree on showcase, deliverables and embargo**. If not: Plan new Green Light meeting (+/- 4 weeks later))									**Submit report, showcase and confidential appendix report** (when applicable) to supervisory team one week prior to graduation day. **Upload deliverables** to TUDelft repository. **Give a public presentation** and lead Q&A session and **join evaluation session** with the supervisors.				**Prepare for publishment if possible**			
Kick off meeting																									
Literature review																									
Visit Jincheng hospital																									
prepare for interview																									
Interview with ICU experts																									
Define problem																									
Exiting data mapping																									
Patient journey																									
HP workflow																									
Trend research																									
Market Research																									
Future visioning																									
Mid-term presentation																									
Technology scouting																									
prepare for interview																									
Interview with AI experts																									
Modular Architecture																									
Time Pacing																									
Draft roadmapping																									
Green light																									
final roadmapping																									
Final deliverables																									
Graduation day																									

Legend: Important Meeting for the whole team — Collaboration (interview/online workshop) — Individual work

My project will last 21 weeks from Mar. 8 until Jul. 30, including one week of break, consisting of investigation & envisioning, exploration & evaluation and roadmapping & finalising stage in an iterative process.

The first eight weeks before the midterm meeting is the investigation & envisioning stage. The research will be conducted to investigate the existing data infrastructure, pain points of patient and workflow of healthcare professionals. A future vision for an AI-based information system to diagnose patients' stress in ICU is expected. The research will be conducted by literature review and semi-structured interviews with health professionals in Erasmus MC. After a visit to Jincheng People Hospital, the insights will be translated to understand the context of ICU in Erasmus MC.

The next eight weeks before the green light meeting is the exploration & evaluation stage, during which new possibilities for practical AI applications will be explored by literature review, market research and brainstorming. The feasibly and viability of new possibilities will be evaluated with AI experts by interviews or online workshop.

In the last four weeks, a roadmap of the steps that are needed to design an AI-based information system to help health professionals diagnose patients' stress in ICU will be created. The final deliverable will be finalised and uploaded.

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.

I want to set up this project because I always believe that health is the fundamental "human right", and I believe in the power of data. Thoughtful use of data can improve work efficiency and help people to make rational decisions. Since AI has an advantage in structured data processing than humans, I am also interested in how AI assist people to make a better decision. Besides, I am familiar with design roadmapping methodology and want to practice based on a real-world problem.

During the Strategic Product Design master program, I focus more on problem framing than how to solve a problem in the right way. I believe only by defining the problem clearly can a designer maximize the impact of a project with limited resources and time. In order to solve the right problem, on the one hand, I have developed professional skills including user research, market research, ideation, design and methodology, and soft skills like storytelling, communication and project management.

Since I am a medisign student, I did three electives related to healthcare, including Capita Selecta Medisign (Design research landscape and practices), Health Psychology: Tools and Methods and Cogn Ergonomics for Complex Systems. Several methods I learned can be used for the graduation project. For example, most ICUs are stressful environment for patients, The Transactional Model of Stress and Coping can be a suitable framework for evaluating processes of coping with stressors in ICU (Glanz et al., 2008, pp.213). After discharge, patients still face significant physical and social limitations caused by a reduced cardiac reserve, pulmonary problems or neurological symptoms (Tilburgs, Nijkamp, Bakker, & van der Hoeven, 2015). It is often valuable to involve family, friends and partners in therapy as social support during and after ICU (Deja et al., 2006). Therefore, the Social Networks and Social Support theory can be used to explain how social networks and social support have positive effects on the physical, mental, and social health of ICU patients (Glanz et al., 2008, pp.193).

During the past 1.5 years, I have learned a lot of design methodologies in different courses. In order to practice the methodologies, sometimes we need to assume the problems of users because of the limited time. The graduation project provides a great opportunity for me to flexibly apply the methodologies based on the real-word problem and provide practical solutions. Besides, different courses have different emphasises on the stages of the design process. For example, some coursed focus on research and others focus on visualisation. In the graduation project, I can go through the whole design process and practice scheduling and managing the project by myself. Also, I can communicate with professionals from healthcare and AI disciplines. This is a great opportunity to explore the strategic value of design in the interdisciplinary context.

FINAL COMMENTS

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

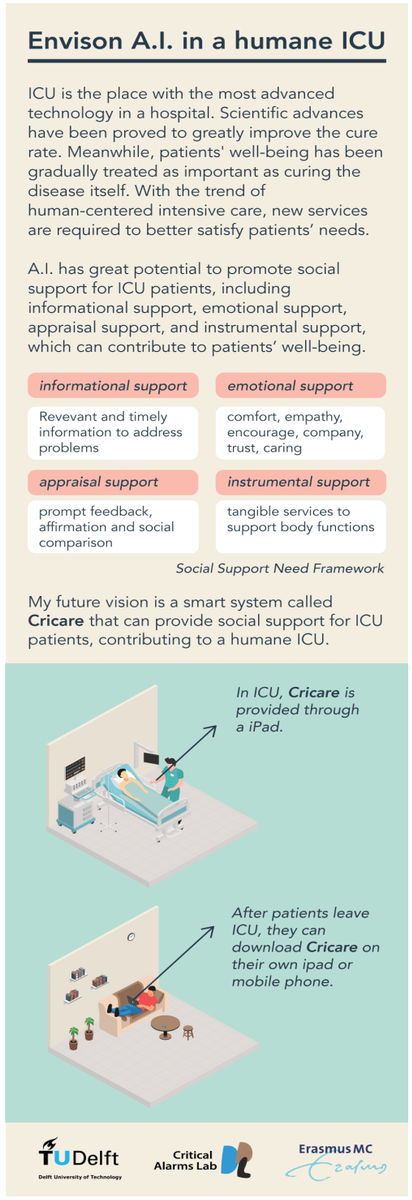
Appendix 2 Questionniare design

Envision A.I. in a humane ICU to provide social support for patients

Hi there. I'm Fei, a design student from TU Delft. Currently I am working on my master graduation project with TU Delft Critical Alarm Lab and Erasmus MC, exploring how artificial intelligence (A.I.) can potentially contribute to a humane ICU. The aim of this questionnaire is to evaluate the design concept.

*Required

The figure below is a brief introduction to my project. Please read it carefully :)



https://docs.google.com/forms/d/1u5y0RejnPZ_xDz4uezupkoEi2QRsmTgkUOAUsgfbew4/edit

The questionnaire consists of 4 parts, including linear scale questions and open questions. It may take around 30 minutes to finish it.

Part 1. Informed consent to participate in this study.
Part 2. Nine services of Cricare to get your opinion.
Part 3. Overall comments about Cricare
Part 4. Background information about yourself

Let's start to explore how A.I. can contribute to a humane ICU !

Informed Consent

Your permission is required to participate in this study. This questionnaire will only collect your experiences and opinions rather than personal or work-related data. The result will be anonymized. If you have any questions, you can contact Fei

1. Please tick the appropriate boxes if you agree to the statements. *

Tick all that apply.

- [ ] 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.
- [ ] I understand this study and be able to ask questions if I have any problems.
- [ ] I understand that information I provide will be used for a master thesis, scientific journals or conference publications.
- [ ] I understand that giving any personal information that can identify me [e.g. my email] is voluntary and will not be shared beyond the researcher (Fei Du).

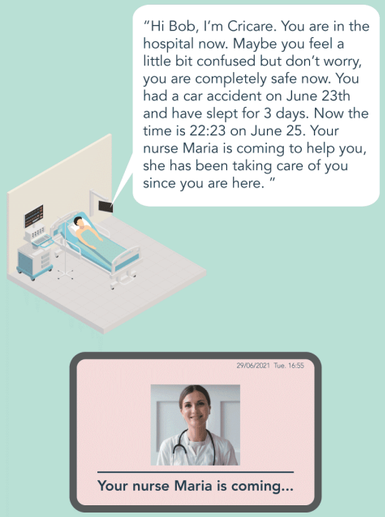
Service 1. Provide orientation when patients wake up

From this section, nine services of Cricare will be presented one by one. You are free to give any comments that pop up in your mind :)

1 | Provide orientation when patients wake up

Many ICU patients experience memory loss and a sense of being 'drugged' because of the acuity of illness, use of sedation to facilitate treatment (e.g. mechanical ventilation) and the prevalence of delirium. They feel confused when they wake up in the ICU.

Cricare can provide orientation when patients wake up. This service happens in the ICU or the ward if the patient is still delirious.



The orientation includes:
- words for comfort
- what accident/surgery happened on which date
- how many days the patient has been in a coma
- an introduction of the nurse who is coming
- current date and time

AI capability

Image recognition: Cricare can recognize when the patients wake up by telling if they open their eyes.

Text-to-Speech: Cricare can provide orientation by speakers based on the EHR of patients.

Nurse input

When patients wake up, Cricare will alarm the nurse and provide orientation before the nurse arrives.

If this is the first time that the patient wakes up, after the nurse checks the state of patients and makes sure they have the ability to meet families, the nurse can push a button to send families a message or trigger a call to let families know that the patient is ready to meet.

2. 1. If this service is provided in ICU, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

3. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

4. 3. To what extent would this service provide proper orientation when patients wake up? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service will help

5. 4. To what extent would this service make patients feel in control of life in ICU? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patient feel in control

6. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

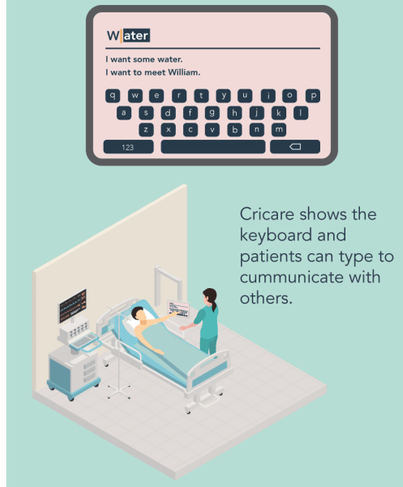
7. 6. How would you improve this service?

Service 2. Help patients communicate by autocomplete

2 | help patients communicate by autocomplete

In ICU, some patients can't speak because of the oxygen mask, which makes it hard to communicate with nurses.

Criticare can help patients by autocompleting the words and sentences that they want to say. It can save time and energy for patients to communicate with others when they can't speak.



AI capability

Autocomplete prediction: machine learning is used to give the most relevant autocomplete result based on popularity, freshness and similarity between target patients and other patients according to EHR data.

Nurse input

When nurses notice that patients want to communicate, they can help open the keyboard on Cricare.

Nurses and patients can enrich the data-base of possible questions when the recommendation result is not accurate.

8. 1. If this service is provided in ICU, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

9. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

10. 3. To what extent would this service help patients to communicate? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service will help

11. 4. To what extent would this service make patients feel in control of life in ICU? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patient feel in control

12. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

13. 6. How would you improve this service?

Service 3. Comfort patients simulating the voice of families

3 | Comfort patients simulating the voice of families

The presence of family members is important for ICU patients, but it's hard for family members to accompany patients anytime they want.

Cricare can simulate the voice of the family to let them calm down when the patient is anxious and delirious. It can also read books for patients regularly during the day to make patients feel less lonely.

AI capability

Voice clone: Cricare can simulate the voice of a family based on pre-recorded voice samples.

Nurse & family input

The family needs to record standard voice samples in order to clone the voice.

Nurses can set how often the Caricare read books based on patients' health condition.

14. 1. If this service is provided in ICU, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

15. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

16. 3. To what extent would this service make patients feel being supported by families? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service will help

17. 4. To what extent would this service help patients feel less lonely? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel less lonely

18. 5. To what extent would this service make patients feel less anxious? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel less anxious

19. 6. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

20. 7. How would you improve this service?

Service 4. Create music based on physiologic signals

4 | Create music based on physiologic signals

Being in ICU is usually a negative experience for patients. Cricare can create music based on the physiologic signals of patients. When patients wake up, they can get personalized music as gifts. The music can make them feel proud of how they manage to overcome the difficult time when they go back home and remember the ICU experience. Besides, the music can be an inspiration for those patients who are musicians to create new music.

AI capability

Machine learning: Cricare creates the theme melody based on patients' habits of listening to music. For example, if the patient is a fan of the Beatles, the theme melody is similar to the style of the Beatles. Then the variations are created based on the physiological signals of patients (heart rate, respiration rate, etc.)

Nurse input

If patients are admitted because of planned surgery, nurses can ask patients' habit of listening to music before they are admitted to ICU.

If patients are admitted because of an accident, nurses can ask families to choose which music may represent the style of the patient.

21. 1. If this service is provided in ICU, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

22. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

23. 3. To what extent would this service help patients feel positive about ICU experience? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	feel less negative

24. 4. To what extent would this service make patients feel proud of managing to overcome the difficult time during ICU? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel proud

25. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

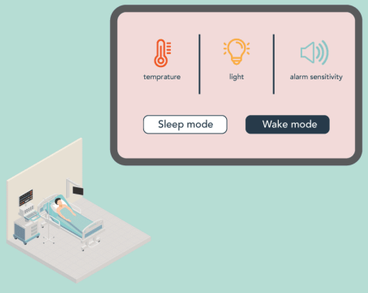
	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

26. 6. How would you improve this service?

Service 5. Adjust environment based on sleep cycle

5 | Adjust environment based on sleep cycle

Many ICU patients have sleep problems. Caricare can suggest nurses adjust the light and temperature level based on the patient's sleep cycle and lower the sensitivity of alarm when patients fall asleep. In case of emergency, if the alarm system rings while patients are sleeping, the light level will gradually become higher before the nurses come.



AI capability

Image recognition: Cricare can recognize if the patient is awake or asleep and automatically switch the mode.

Machine learning: Cricare can reduce false alarms based on signal processing and feature extraction.

Nurse input

Nurses can check the settings of sleep mode and wake mode.

27. 1. If this service is provided in ICU, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

28. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

29. 3. To what extent would this service help patients to sleep well? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service would help

30. 4. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

31. 5. How would you improve this service?

Service 6. Provide relevant information and answer patients' questions

6 | Provide relevant information and answer patients' questions

In the ICU, sometimes patients don't want to ask nurses awkward questions like what happened when catheters are removed. Besides, after discharge, when patients want more information, they don't know where to obtain it.

Cricare can provide relevant information for patients or answer questions that patients ask, including:
- Could you explain my disease?
- What will happen to me until recovery?
- How long can I get out of the hospital?
- When can my families visit me?
- What will happen when catheters are removed?

……

AI capability

Collaborative filtering: Cricare can give the most relevant articles based on the similarity between target patients and other patients according to EHR data.

Machine learning and Natural language processing (NLP): Cricare can provide human-like conversational experience.

Nurse input

The nurse will answer the question if Cricare can't handle it and update the database.

32. 1. If this service is provided in ICU and after discharge, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

33. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

34. 3. To what extent would this service help patients to obtain information? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service would help

35. 4. To what extent would this service make patients feel in control of life? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel in control

36. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

37. 6. How would you improve this service?

Service 7. Communicate with an avatar about sufferings

7 | Communicate with an avatar about sufferings

When patients feel unmotivated or anxious, but they don't want to show their pain to families, they can communicate with Cricare about their pain and sufferings.

This service happens in the ICU when patients can speak or type, in the ward, or after discharge.

AI capability

Machine learning and Natural language processing (NLP): Cricare can provide human-like conversational experience.

Affective computing: Cricare can interpret the patients' emotion.

Psychologiest input

If Cricare recognizes that the patient has a mental health problem, the test result will be sent to a psychologist for further treatment after getting the patient's consent.

38. 1. If this service is provided in ICU and after discharge, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

39. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

40. 3. To what extent would this service help patients deal with emotion problems? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service would help

41. 4. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

42. 5. How would you improve this service?

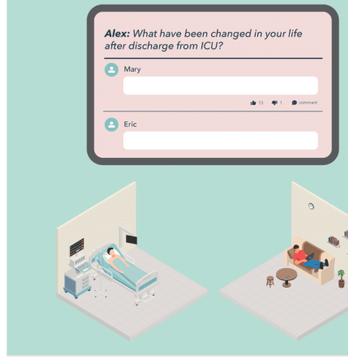
Service 8. Find other patients who have similar experience

8 | Find other patients who have similar experience

By communicating and comparing with paitents who had similar experience and already recovered, ICU pateints can become more rational about their own recovery process and feel supported by a community.

Cricare can create an online community for ICU patients and post-ICU patients to share experience. ICU patients may find similar patient online to have a chat. Patients can also ask questions in the online community to get answers from recovered patients.

This service happens in the ICU when patients can speak or type, in the ward, or after discharge.



AI capability

Collaborative filtering: Cricare can find the most relevant patients based on the similarity between target patients and other patients according to EHR data.

Recovered patient input

Every ICU patient will be asked if they want to join the online support community and share their data for the recommendation algorithm.

Recovered patients can get a notification to answer the questions from patients who have similar experiences based on the EHR data.

43. 1. If this service is provided in ICU and after discharge, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

44. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

45. 3. To what extent would this service make patients feel supportive? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service will help

46. 4. To what extent would this service help patients find relevant information? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	this service will help

47. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

48. 6. How would you improve this service?

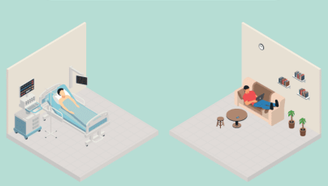
Service 9. Suggest patients to set small goals

9 | Suggest patients to set small goals

Many ICU patients feel unmotivated because of the severity of the disease and terrified by the fact that they need to stay in ICU for a long time. Some patients feel disappointed after discharge because they can't go back to the normal life as they expected.

Caricare can motivate patients by suggesting they set small goals. Patients can get a feeling of control gradually and regain the hope of getting back to normal life.

This service happens in the ICU when patients can speak or type, in the ward, or after discharge.



AI capability

Collaborative filtering: Cricare can show examples of similar recovered patients and give goal-setting suggestions based on the similarity between target patients and other patients according to EHR data.

Nurse input

Nurses can check the feasibility of the goal.

49. 1. If this service is provided in ICU and after discharge, how would you feel? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

50. 2. How important is this service to patients? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	important

51. 3. To what extent would this service make patients feel in control of life in ICU? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel in control

52. 4. To what extent would this service make patients feel motivated? *

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	make patients feel motivated

53. 5. To what extent would this service promote patients' well-being?

Mark only one oval.

	1	2	3	4	5	
not at all	◯	◯	◯	◯	◯	promote patients' well-being

54. 6. How would you improve this service?

Overall comment

55. In general how do you feel about Cricare ? *

Mark only one oval.

	1	2	3	4	5	
I dislike it	◯	◯	◯	◯	◯	I like it

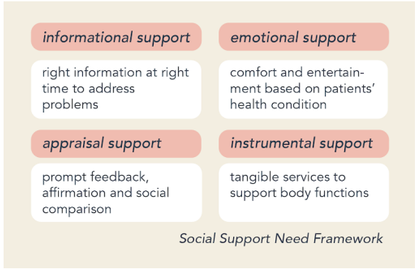
56. Could you pick 3 favourite ideas? *

Tick all that apply.

- ☐ Service 1. Provide orientation when patients wake up
- ☐ Service 2. Help patients communicate by autocomplete
- ☐ Service 3. Comfort patients simulating the voice of families
- ☐ Service 4. Create music based on physiologic signals
- ☐ Service 5. Adjust environment based on sleep cycle
- ☐ Service 6. Provide relevant information and answer patients' questions
- ☐ Service 7. Communicate with an avatar about sufferings
- ☐ Service 8. Find other patients who have similar experience
- ☐ Service 9. Suggest patients to set small goals

57. Please give any comments on Cricare that pop up in your mind :)

58. Would you like to share any other idea on how A.I. can possibly provide social support for patients and contribute to a humane ICU? You can use the figure below as an inspiration :)



Social Support Need Framework

Basic information

59. What's your role in ICU? *

Mark only one oval.

- ◯ Nurse
- ◯ physician
- ◯ Other: _____

60. How many years have you been working in ICU? *

Mark only one oval.

- ◯ less than 2 year
- ◯ 2-5 years
- ◯ 5-10 years
- ◯ >10 years

61. What's your age range? *

Mark only one oval.

- ◯ 18-20
- ◯ 20-30
- ◯ 30-40
- ◯ 40-50
- ◯ 50-60
- ◯ >60

62. What's your gender? *

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Prefer not to say

63. Thanks a lot for your time! If you would like to talk more about A.I. in ICU, please leave your email here for a follow-up interview :)

64. How satisfied were you with this questionnaire?

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

Appendix 3 Questionniare result

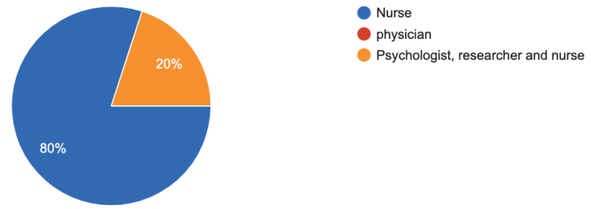
1. If this service is provided in ICU, how would you feel?									
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
Participant 1	5	4	4	4	4	2	3	4	5
Participant 2	4	2	4	4	4	2	3	4	3
Participant 3	3	5	3	4	4	1	1	5	4
Participant 4	3	5	4	4	4	3	5	5	4
Participant 5	2	2	1	3	4	1	1	4	2
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
highest	5	5	4	4	4	3	5	5	5
lowest	2	2	1	3	4	1	1	4	2
Mean	3,4	3,6	3,2	3,8	4	1,8	2,6	4,4	3,6
2. How important is this service to patients?									
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
Participant 1	5	4	4	4	4	2	3	4	5
Participant 2	4	3	5	4	4	3	3	4	3
Participant 3	4	5	3	4	4	2	2	5	4
Participant 4	4	4	3	2	4	3	5	5	4
Participant 5	3	1	1	3	4	1	1	4	2
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
highest	5	5	5	4	4	3	5	5	5
lowest	3	1	1	2	4	1	1	4	2
Mean	4	3,4	3,2	3,4	4	2,2	2,8	4,4	3,6
5. To what extent would this service promote patients' well-being?									
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
Participant 1	5	3	4	4	4	2	3	4	5
Participant 2	3	3	4	4	4	2	3	4	4
Participant 3	3	5	3	4	4	2	2	5	4
Participant 4	4	5	4	2	4	3	5	5	4
Participant 5	2	1	2	3	4	1	1	3	3
	1.Orientation	2.Autocomplete	3.Voice Simulator	4.Music Creator	5.Environment adjuster	6.Chatbot	7.Virtual Psychologist	8.Peer support	9.Goal setter
highest	5	5	4	4	4	3	5	5	5
lowest	2	1	2	2	4	1	1	3	3
Mean	3,4	3,4	3,4	3,4	4	2	2,8	4,2	4

Idea	Question	Social support	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
1.Orientation	3. To what extent would this service provide proper orientation when patients wake up?	informational support	4	4	4	2	4
	4. To what extent would this service make patients feel in control of life in ICU?	emotional support	4	3	3	2	1
2.Autocomplete	3. To what extent would this service help patients to communicate?	instrumental support	3	3	5	5	1
	4. To what extent would this service make patients feel in control of life in ICU?	emotional support	3	3	5	5	1
3.Voice Simulator	3. To what extent would this service make patients feel being supported by families?	Appraisal support	3	4	3	4	3
	4. To what extent would this service help patients feel less lonely?	emotional support	3	5	3	4	3
	5. To what extent would this service make patients feel less anxious?	emotional support	4	3	3	3	2
4.Music Creator	3. To what extent would this service help patients feel positive about ICU experience?	emotional support	3	4	4	2	3
	4. To what extent would this service make patients feel proud of managing to overcome the difficult time during ICU?	emotional support	3	4	4	2	3
5.Environment adjuster	3. To what extent would this service help patients to sleep well?	instrumental support	4	4	4	4	4
6.Chatbot	3. To what extent would this service help patients to obtain information?	informational support	1	2	1	3	1
	4. To what extent would this service make patients feel in control of life?	emotional support	2	2	2	3	1
7.Virtual Psychologist	3. To what extent would this service help patients deal with emotion problems?	emotional support	3	3	2	5	1
8.Peer support	3. To what extent would this service make patients feel supportive?	Appraisal support	4	4	5	5	5
	4. To what extent would this service help patients find relevant information?	informational support	4	4	5	5	2
9.Goal setter	3. To what extent would this service make patients feel in control of life in ICU?	emotional support	5	4	4	4	3
	4. To what extent would this service make patients feel motivated?	emotional support	5	4	4	4	3

6. How would you improve this service?	
Idea	
1.Orientation	Repetition of the message
	Please use 'sleep' in stead of days in coma. Include information on familiy. Have a repeat, because patients are dizze, sleepy, desoriented and forgetful.
	It depends completely on the patient and his/her illness if this would be a helpful tool, or if this would make them very restless for example.
2.Autocomplete	The problem is that the patiënt has to type. A lot of patiënt can't So I would like addition of pictures
	I do not know. It is not as simple as it seems to provide a device working in communication. There already are apps, which are under development for further improvement
3.Voice Simulator	I think a voice van be comforting but can never replace the real présence of family members
4.Music Creator	I don't der hoe this service van make anybody proud. I think it is important that patiënts can listen to music but maybe at first to music that is known to be reassuring instead of music of the patiënts own taste
	This kind of research is ongoing
	It could also be a bad reminder to a very bad, painful and lonely time. Also totally depends on the type of patient.
5.Environment adjuster	This service has to take in account that a lot of our patiënts have a disordered Day and nigh rythm. Do even when the patiënt is awake but it's nighttime it cannot switch to a daytime mode
	If, for example, a patient is delirious and falls asleep during the day, this would be NOT preferable. We would not want a device to support this behaviour in a way which is not wanted or preferred by nurses. So it would be nice to have a setting for time-blocks for example.
6.Chatbot	I think in this particular area a nurse is needed because answers aren't black and white. Every situation is different and needs it's own approach.
	Most patient are not cognitively able to read. Providing information is helpful, AI might support that. Important to take into account that they do not respond as 'normal' awakening persons
	This could be a tricky one, since every patient is different and for example; we have a lot of Neuro-patients and their recovery and residual symptoms are literally different for every single patient. This would be very difficult to give as one answer, plus it would be very much work for the nurses to have to fill this in for every patient.
7.Virtual Psychologist	I find it hard to tell hoe this will work
	I can not judge on this
8.Peer support	A service like this is already available on IC Connect. A patiënt platform especially for icu patiënts. One can direct to that I don't know if another platform is needed.
	Not during the ICU, however after discharge it can be valuable. There is already a lot ongoing in finding peer support
9.Goal setter	Include also a rehabilitation schedule (input nu a fysiotherapist)

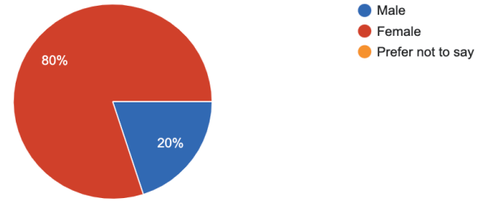
What's your role in ICU?

5 responses



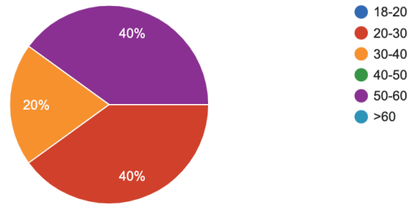
What's your gender?

5 responses



What's your age range?

5 responses



What's your gender?

5 responses