



THE ART OF HANDING OVER

Improving the patient handovers at the ICU
by human-centred design

- a project by Laura Schrauwen -

MASTER THESIS

Design for Interaction - Medisign

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The art of handing over:
Improving patient handovers at the ICU by design

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THE ART OF HANDING OVER

EXECUTIVE SUMMARY

Background

This graduation project aimed to enhance the patient handovers at the Intensive Care Unit (ICU) by design based on experienced qualities and pain points by the ICU team, existing of doctors and nurses.

At the ICU, care is delivered by multidisciplinary healthcare teams who strongly rely on teamwork and communication. Patient handovers are scheduled moments of communication, where information between different healthcare professionals is exchanged. However, there exists an unaccepted rate of unintended patient harm which can be attributed to failures in communication. These failures can be the result of educational, psychological, and organizational factors.

Three ingredients for handover enhancement

To discover how design can overcome these failures in information sharing, observations and interviews within the ICU context were done. The aim of the observations was to understand and interpret the behaviour of ICU doctors and nurses throughout the day and during handovers. The purpose of the interviews was to get a deeper understanding of their personal experience with the different handover moments. The observations provided insights in the interactions between doctors, nurses, and both groups. Discovered communication breakdowns were captured in three different work models. The interviews revealed the experienced qualities and pain points during handovers. Altogether, both activities resulted in three ingredients which need to be considered while designing for enhanced handovers: information sharing, teamwork, and context.

Practicing the art of handing over

I envisioned to design a tool that assists ICU doctors and nurses to practice the art of handing over: sharing only the relevant patient information during every handover and thereby carefully taking the personal interests of each attendant into account in order to make these medical meetings feel effective and efficient for everyone. Thereby, it is desired that a design covers minimal one and preferably all three ingredients found.

ICoon: 'overdragen', 'overzien', 'over hebben'

Based on the findings, ICoon was developed in extensive collaboration with the ICU team. ICoon is a tool facilitating that the patient handovers are experienced as more effective and efficient. The tool exists of three different components:

'overdragen', 'overhebben', and 'overzien' (or in English: 'communicate', 'automate', and 'evaluate'). 'Overdragen', allows that the complete ICU team will have the same expectations of each handover moment and entails that only relevant information is shared in an efficient way. 'Overzien' is an addition to the current Patient Data Management System (PDMS), allowing the ICU team to have a proper overview of the patient population on each unit and is supportive in efficiently handing over patients during shift changes. The last component, 'over hebben', will enable the ICU team to continuously reflect together on their handover process triggering organizational change.

Evaluating the created design

The last step of this design process was to elaborately evaluate ICoon with the ICU team. The aim of the evaluation was twofold: figuring out the added value of ICoon within the ICU regarding the experienced effectiveness and efficiency and assessing the support 'overzien' facilitates during patient handovers. Therefore, the evaluation consisted of two parts: evaluation by conversation and evaluation in practice. During the evaluations, it was confirmed that each component of ICoon provides a different main added value to the ICU team.

Compared to the current situation, the ICU team agreed that 'overdragen' provides focus and structure, 'overzien' brings overview, and 'over hebben' can have a positive impact on the teamwork within and between the team of nurses and team of doctors.

Aiming for transformation

The concept ICoon in combination with the involvement of the ICU team resulted into tools and capacities for the realization of innovation at the ICU. The adopted human-centred design approach and engagement with the doctors as well as the nurses resulted into co-commitment of the ICU team, which turned out to be an important first step towards implementation of design solutions within the ICU. Therefore, ICoon turned out to serve as tool for transformation rather than a design solution only.

LIST OF ABBREVIATIONS

AIOS

Abbreviation for a resident doing a further specialization after being graduated as a regular doctor.

In Dutch: Arts In Opleiding tot Specialist

ANIOS

Abbreviation for a resident not doing any further specialization after being graduated as a regular doctor.

In Dutch: Arts Niet In Opleiding tot Specialist

EMC

Erasmus Medical Centre

In Dutch: Erasmus Medisch Centrum

EMR

Electronic Medical Record.

In Dutch EPD (Elektronisch Patiënten Dossier)

ICU

Intensive Care Unit

IDE

Industrial Design Engineering

LUMC

Leiden University Medical Centre

In Dutch: Leids Universitair Medisch Centrum

MCU

Medium Care Unit

MDT

Multidisciplinary Team Meeting

In Dutch MDO (Multidisciplinair Overleg)

PDMS

Patient Data Management System

In Dutch: Patiënt Data Management Systeem

SBAR

System Background Assessment Recommendation



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1.0 | INTRODUCTION

This master thesis represents my graduation project about improving the patient handovers at the ICU by design. The project was done in collaboration with the Intensive Care Unit (ICU) at Leiden University Medical Centre (LUMC), the university hospital affiliated with Leiden University. At the ICU, patients get specialized treatments because of (possible) life-threatening problems with the vital functions, such as respiration, heart function, blood pressure, and the functioning of the brain.

By designing, I aim to improve people's quality of life. My desires to become an artist or veterinarian at first, resulted in becoming a designer focused on healthcare challenges. Therefore, many of my past projects were focused on different kinds of patients, by investigating how design and technology could impact their quality of life and happiness.

However, in a healthcare context the care providers are important stakeholders to consider as well. How can design assist them in their work, to eventually enhance patient care? The fact that my previous projects were mainly focused on the patient instead of the care providers was the reason why I was so interested in this project. How can design assist ICU doctors and nurses in enhancing their care provision? The handovers at the ICU seemed to be an interesting phenomenon to study, as the treatment goals and plans for each patient are discussed and decided here. The handovers directly have an influence on the patient's course.

Although it is of vital importance that all members of the ICU team understand exactly what the treatment goals are and how to proceed as a team, unfortunately, the handovers within the ICU are not yet optimal. The current flow of the handovers can cause that prioritization, expected outcome, important details, and views of the previous ICU team may get forgotten or misinterpreted by the current ICU team. For this reason, this project aimed to enhance the patient handovers within the ICU team (existing of doctors and nursing staff), in a way that managing patient care would become more efficient and effective. Moreover, a better understanding of the patient's needs among the ICU team was needed to be realized. Therefore, the main question to be answered during this project was:

HOW CAN WE ACHIEVE THAT THE PATIENT HANDOVERS ARE EXPERIENCED AS EFFECTIVE AND EFFICIENT, AND SIMULTANEOUSLY REALIZE A BETTER SHARED UNDERSTANDING OF PATIENTS' NEEDS AMONG THE ICU TEAM?

Patient handovers include all the scheduled moments of information sharing between the ICU team. Handovers intended for department change or hospital transfer are not within the scope of this project.

Effective means that the handover should be successful in transferring the right and relevant patient information. *Efficient* means that the handovers can be finished within a limited timeslot.

Achieving a *shared understanding of patients' needs* is the main goal of a handover but is also most challenging as the ICU includes a variety of complex patients with different needs.

The *ICU team* includes the team of doctors and nurses working at the ICU.

To answer this question, the design process as visualized in figure 1 was followed. In this report, each step of the design process will elaborately be explained. It starts with an explanation of the ICU context and the patient handovers, followed by the fieldwork that was done to reveal the needs of the ICU team regarding the handovers. After that, based on the constructed design goal and vision, the conceptualisation process resulting into the final design, ICoon, is explained. This report ends with an evaluation of ICoon including future recommendations and limitations, a conclusion answering the main question, and a personal reflection on the project.

All in all, it was a pleasure to do this project as a graduation project for my study Design for Interaction in combination with the Medesign specialisation. The research topic and human-centred approach throughout my process can be seen as a summary of everything I learned throughout my career at the TU Delft. Therefore, I am very thankful I got the opportunity to do this project in collaboration with the LUMC.

Enjoy reading my master thesis.

LAURA SCHRAUWEN

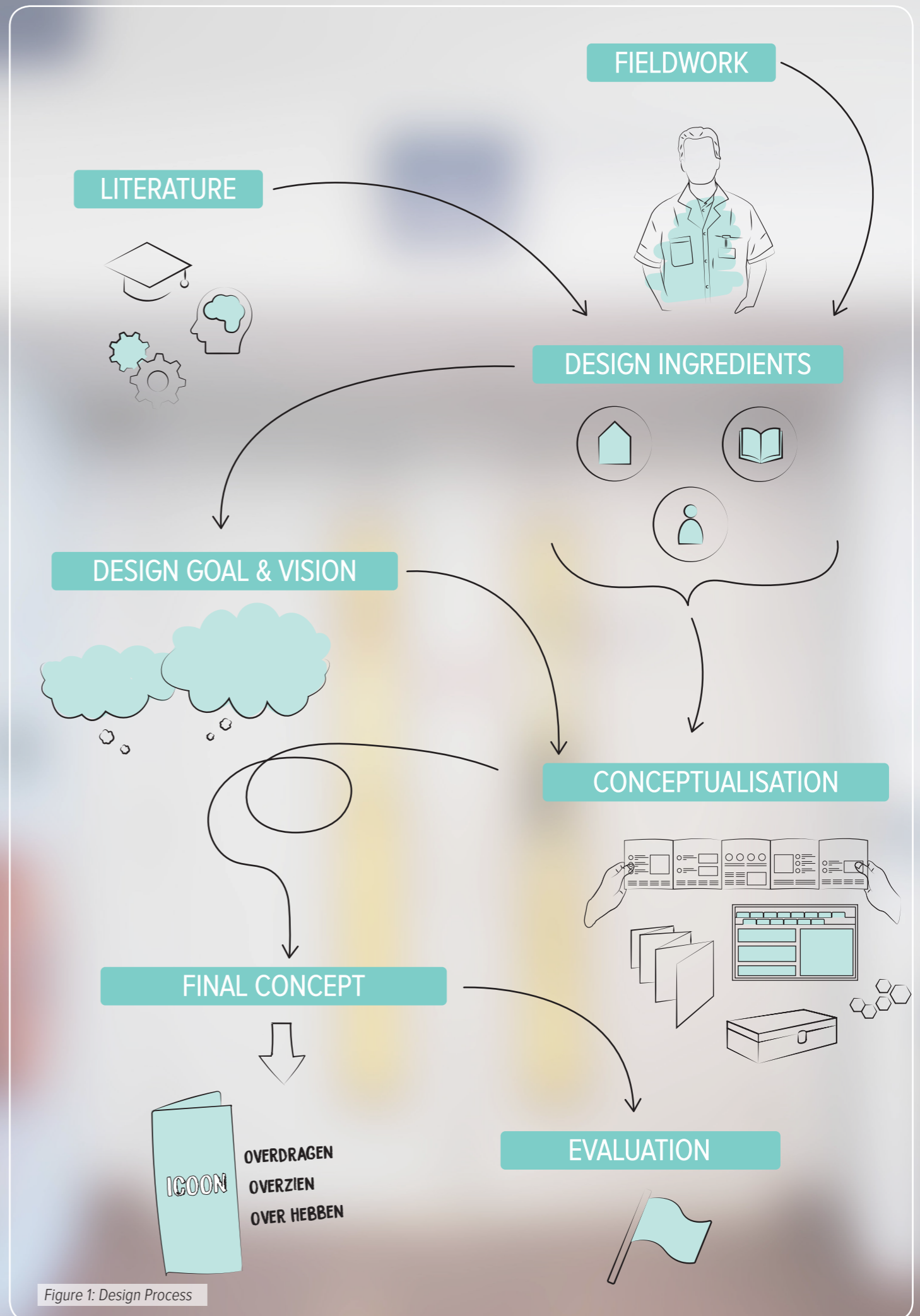


Figure 1: Design Process

2.0 | THE ICU CONTEXT

Yearly, about 85.000 people are admitted to Intensive Care Units in the Netherlands (ZorginstituutNederland, 2019). An ICU is an organized system for the provision of care for critically ill patients. Admitted patients can be provided with intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency (Marshall, et al., 2017). Patients admitted to the ICU need 24 hours a day specialized medical care, and admission can either be planned or acute. The timespan of admission can vary a lot per patient: it can last for hours, weeks, or even for months (ZorginstituutNederland, 2019). ICUs are staffed by highly trained doctors and nurses who are specialized in caring for critically ill patients. This chapter describes what an ICU is, which specialties and technologies are available, what the working culture contains, and which specialists are involved in intensive care.

- 2.1 The ICU at LUMC
- 2.2 Specialties & technologies
- 2.3 Work culture
- 2.4 The ICU team



Figure 2: The ICU at the LUMC.



Figure 3: The ICU at the LUMC.

2.1 THE ICU AT THE LUMC

The LUMC is one of the eight university medical centres in the Netherlands. At the ICU within this hospital, they care for the most critically ill patients. Therefore, their ICU can be labelled as a level 3 ICU, which is the highest ICU level.

3 different ICU levels

A level 1 ICU is capable of providing oxygen, non-invasive monitoring, and more intensive nursing care than on a ward. A level 2 ICU can provide invasive monitoring and basic life support for a short period of time. A level 3 ICU provides a full spectrum of monitoring and life support technologies (Marshall, et al., 2017). Moreover, a level 3 ICU has a higher nurse-patient ratio (often 1:1) compared to lower levels and includes more intensivists per ICU bed (Kluge, et al., 2015). Furthermore, ICUs of this highest level may actively be focused on research and education. This mainly occurs in academic hospitals, which are institutions combining the services of a hospital with education of medical students and research, such as the LUMC (Marshall, et al., 2017).

How the unit originated

Traditionally, the ICU at the LUMC existed of four different specialisms: general surgery, thoracic surgery, internal medicine, and neurosurgery. Merging them in resulted in two general ICUs: Unit 1/2 and Unit 3/4.

In total, there is room for 28 IC patients, which means 14 per unit. However, a shortage of personnel causes that the department cannot afford full occupation. Each unit is fully occupied when 11 patients are admitted (S.A. Goedemans – de Graaf, personal communication, October 22, 2019). The rooms, or ‘boxes’ at the unit exist of double rooms, single rooms, and isolation rooms. Each room has a sink and

allows to easily access the devices and monitors surrounding the patient. Furthermore, the patient’s bed is always located in the middle of room to make sure the patient is accessible from all sides.

Medium care

Next to two ICUs, a Medium Care Unit (MCU) is also located within the hospital. The distinction between the ICU and MCU is that the condition of the MCU patient is more stable. Therefore, less intensive treatment and care provision is necessary compared to ICU patients (LUMC, 2018).



2.2 SPECIALTIES & TECHNOLOGIES

Specialties

Intensive care is a multidisciplinary and interprofessional specialty. Although its practitioners share common expertise in acute organ system insufficiency management, they also come from various specialty backgrounds that provide additional clinical expertise, such as anaesthesia, surgery, pulmonology, emergency medicine, and paediatrics (Marshall, et al., 2017).

Technologies

Intensive care uses an array of technologies that provide support of failing organ systems, particularly hemodynamic, respiratory, and renal support. An example of technological hemodynamic and respiratory support is ECMO therapy (Extracorporeal membrane oxygenation) in which the function of the heart and/or lungs can be (partially) taken over by an external device for a specific period of time. Solely respiratory support may range from the delivery of supplemental oxygen via a mask to complete intubation. Renal support in the form of intermittent or continuous renal replacement therapy with an external device is often needed by an ICU patient as well. The Continuous Veno-Venous Hemofiltration (CVVH) and haemodialysis are both renal support treatments that are frequently provided at the ICU (Marshall, et al., 2017).

Besides support in failing organ systems, the ability to perform continuous patient monitoring characterizes the ICU as well. Monitoring may be non-invasive or invasive and data is displayed continuously and simultaneously recorded, so that the ICU team can respond immediately and appropriately (Marshall, et al., 2017).

2.3 WORK CULTURE

Culture

Culture can be defined as shared knowledge and customary actions, constituted by social systems, manifest in the rules, roles, relationships, and actions of persons (Baggs, et al., 2007). The culture of an environment assists members of that culture to determine what is important in a situation, how interactions should take place, and in what ways they can affirm their beliefs, values, and norms.

The intensive care environment contributes to a culture of doctors and nurses which have distinctive social patterns compared to those working at other hospital units, as they have to adapt to a fast-paced and stressful environment by functioning within their own culture (Scholz, Nel, Poggenpoel, & Myburgh, 2016).

Culture at the LUMC

As mentioned earlier, intensive care is a multidisciplinary and interprofessional specialty, which means the ICU team exists of professionals from various specialty backgrounds and therefore come from various hospitals. This also has a direct impact on the culture within the ICU, as every individual takes a part of this different work culture to the ICU. At the LUMC, especially when comparing the nursing teams, even cultural differences between both units are clearly visible. For example, the place where they have breaks, behind which unit desk they preferably sit, and how they prefer to divide the patients over the unit slightly differs and impacts the way they interact with each other as well. An explanation about the complete ICU team can be found in the next sub-chapter.



▶ Team of ICU nurses

ABOUT

A specialized ICU nurse has received special training to be qualified to work at the intensive care. Their duties include constantly monitoring the patient, administering treatment, and providing continuous support during the recovery of a patient.

ROLES & RESPONSIBILITIES

Their general responsibility is providing all necessary care to patients, assisting colleagues, and being the point of contact for family. When assigned as senior nurse, additional to the regular tasks an ICU nurse is responsible for, this nurse keeps an eye on all colleagues and leads the shift change.



▶ The intensivist

ABOUT

An intensivist is a specialized doctor who has obtained additional expertise in intensive care after having completed a specialization in another discipline. The intensivist is the director of all patients admitted to the unit and responsible for diagnostics and medical treatments provided.

ROLES & RESPONSIBILITIES

In general, the intensivists are the main responsible doctors. They keep an overview of the patients on a specific unit and perform medical procedures. Furthermore, they supervise fellows and residents. Some days, their role can be on duty (24 h a day in house), non-clinical (focus on research and education), or coordinator (overview over both units).



▶ The fellow intensivist

ABOUT

The fellow intensivist is in training to become intensivist, which takes 2 years. The main tasks include supervising residents and coordinating patient care at the IC units, supervised by an intensivist. During the course of the training, the supervising and coordinating role of the fellow will increase.

ROLES & RESPONSIBILITIES

They work, depending on experience, partly independently and under the supervision of an intensivist. Furthermore, they keep an overview of the patients on the unit and perform medical procedures. Some days, they are part of the Emergency Intervention Team.



▶ The residents (AIOS and ANIOS)

ABOUT

A resident is doing further specialization after being graduated as a regular doctor. Residents working at the ICU are specializing themselves in surgery, anaesthesiology, internal medicine, cardiology or emergency doctor. Working at the intensive care is a mandatory internship for residents.

ROLES & RESPONSIBILITIES

The residents work under the supervision of an intensivist. When on duty, they are responsible for communicating the patients during the morning shift change. Depending on their experience, they may independently execute a medical round and perform medical procedures.

2.3 THE ICU TEAM

The clinical team providing care in an ICU is specially qualified, interdisciplinary, and inter-professional. The ICU team at the LUMC adult ICU exists of doctors (intensivists, fellow intensivists, and residents) and ICU nurses. Furthermore, at the ICU you can find patients, family, care assistants, management, the secretary, and different services. Besides the people directly present on the unit,

other medical professionals contribute to care delivery as well. These professionals include respiratory therapists, physiotherapists, pharmacists, microbiologists, social workers, ethicists, and many others (Marshall, et al., 2017). On the left, you can find an explanation of the role of ICU doctors and nurses. Below, additional stakeholders are briefly explained as well.

Additional stakeholders



▶ Different specialists

Specialists are officially consultant for the IC, but they are mostly seen as co-treatment providers. These professionals include respiratory therapists, physiotherapists, pharmacists, microbiologists, social workers, ethicists, and many others.



▶ Management

The management of the department is formed by the head of the department, the nursing manager, and the different nursing team leaders of each unit. Together they are responsible for the functioning and development of the ICU.



▶ Care assistants

Care assistants support the IC nurses. Their tasks include logistical, household, and minimal care tasks.



▶ Patient & family

The patient undergoes the treatment at the ICU and the family is allowed to visit the patient in the dedicated time slots.



▶ Medical secretary

The secretary makes sure all patients are registered correctly and completely in the Electronic Medical Record (EMR) and Patient Data Management System (PDMS), pick up the phone and puts calling people through with the right persons.



▶ Services

Services include amongst others cleaning services and ICT services.

3.0 | PATIENT HANDOVERS AT THE ICU

Modern healthcare is delivered by multidisciplinary, distributed healthcare teams who rely on effective teamwork and communication to ensure effective and safe patient care. However, there is an unaccepted rate of unintended patient harm. Much of this is attributed to failures in teamwork and communication, which leads directly to compromised patient care, staff distress, tension, and inefficiency. Moreover, these failures can make a contribution to medical error, and are a contributory factors in 61% of sentinel events (Weller, Boyd, & Cumin, 2014). As handovers are frequent and unavoidable processes (Sirgo Rodríguez, et al., 2018) where information is exchanged between different healthcare professionals, these medical meetings can be the source of teamwork and communication problems.

This chapter elaborates on patient handovers: What are patient handovers and why are these medical meetings the source of teamwork and communication problems according to literature? This chapter ends with the state of the art, existing interventions to improve patient handovers.

- 3.1 Patient handovers: definition and varieties
- 3.2 Pain points found in literature
- 3.3 State of the art: Existing interventions to improve patient handovers

3.1 PATIENT HANDOVERS: DEFINITION AND VARIETIES

Patient handovers

A handover is a process that involves the passing of responsibility for some or all aspects of care for a patient, or group of patients and the sharing of relevant patient information (Wilson, Randell, Galliers, & Woodward, 2009). As patient care responsibility is transferred or shared among different healthcare professionals, the communication between them is fundamental for the continuity of patient care (Cohen, Hilli Goss, Carlos, & Amaral, 2012). Information shared during handovers includes clinical information, functional status, changes in clinical status, and plan of care as well as psychological and social issues (Matic, Davidson, & Salamonsen, 2011).

Intra-disciplinary and inter-disciplinary

At the LUMC, the doctors and nurses have several daily scheduled handover moments within their department. These be divided into *intra-disciplinary* handovers and *inter-disciplinary* handovers (Sirgo Rodríguez, et al., 2018). *Intra-disciplinary* handovers occur between healthcare professionals that have had the same academic training (doctor - doctor). *Inter-disciplinary* handovers occur between healthcare professionals that have had different academic trainings (doctors - nurse). To enhance communication about the patient data, both the ICU doctors and nurses document their findings in different files of the PDMS.

Handovers at the LUMC

In case of the LUMC, the shift changes (day, evening, and night) are the short, intra-disciplinary meetings where the old team transfers patient information to the new team. These meetings take place three times a day and are done separately by the doctors and nurses. The bedside ward round, the medical round, and the occasional bedside questions or updates involve direct interaction between the doctors and nurses and can therefore be categorised as inter-disciplinary.

During the bedside ward round, the team of doctors passes by each patient's room, which an opportunity for the nurses to ask (acute) questions regarding their patient. During the medical round, the nurses visit the doctor's room one by one to discuss their patients elaborately with them. Multidisciplinary Team Meetings (MDTs) are attended by ICU doctors and different specialists. During the MDTs, the most complex patients are discussed.

3.2 PAIN POINTS FOUND IN LITERATURE

Communication failures

Literature about teamwork in healthcare has shown that patient handovers as change of shift and information sharing moments between doctors and nurses currently are inadequate (Weller, Boyd, & Cumin, 2014). Communication failures can be caused by difficulties in transmitting relevant information in an orderly manner, excessive information, difficulties in remembering part of the information, fear of asking questions, lack of standardization of the process, surroundings, time pressure, complexity of patients, and training of the staff (Sirgo Rodríguez, et al., 2018). In short, failures in information sharing can be a consequence of educational, psychological, and organizational factors (Figure 4), (Weller, Boyd, & Cumin, 2014).

Co-constructing an understanding of a patient

Besides the previously mentioned communication failures, even accurate transmission of information from one caregiver to another does not suffice that handovers will accomplish the purpose of everyone being on the same page. The reason for this is that handovers require that both participating parties co-construct a common understanding of the patient(s). This means that handovers require conversations rather than only one-way communication (Cohen, Hilli Goss, Carlos, & Amaral, 2012). This makes pain points involved in handover communication even more complex to solve.

“HANDOVERS REQUIRE THAT BOTH PARTICIPATING PARTIES CO-CONSTRUCT A COMMON UNDERSTANDING OF THE PATIENT. THIS MEANS THAT HANDOVERS REQUIRE CONVERSATIONS RATHER THAN ONLY ONE-WAY COMMUNICATION”

- (Cohen, Hilli Goss, Carlos, & Amaral, 2012)



Figure 4: Failures in formation sharing can be the consequence of educational, psychological, and organizational factors.

3.3 STATE OF THE ART: EXISTING INTERVENTIONS TO IMPROVE HANDOVERS

Existing interventions found in literature

Effective care provision by a healthcare team relies on a common understanding of the situation, the plan for treatment, and the roles and tasks among the team. This is often described as ‘being on the same page’ (Weller, Boyd, & Cumin, 2014). Moreover, Cohen, et al. (2012) argues that the fundamental aspect of a handover is using the mental models of all participants to generate a more accurate understanding of the patient.

There already exist interventions to support patient handovers in different ways. This page presents some of these existing interventions which were found during a n explorative literature search.

Conclusion

Conclusively, different interventions aiming to enhance patient handovers already exist. However, the effectiveness of many has not been evaluated yet. Moreover,

implementation of these newly designed tools often appears to be difficult in hospital cultures. Furthermore, most interventions found were not especially designed for ICUs. Therefore, these interventions might not be suitable for ICUs, as the variety of patients admitted to ICUs in combination with the different specialists involved form the biggest challenges for designing a successful intervention for enhanced patient handovers.

Different educational programs

Most doctors receive little or no education in handovers. However, some existing educational programs can be found in literature. These include programs about information management, teamwork and communication, error awareness, and professional behaviour. The teaching methods found included group session/lecture, simulation, role-play exercises, and online materials, such as videos and protocols. However, evidence for the effectiveness of these educational interventions is still unclear (Gordon & Findley, 2011).

Handover improvement campaigns

The I-PASS program developed by Starmer et al. (2014) is an example of a handover improvement campaign. It was designed for inpatient units at nine pediatric residency training programs in the United States. The program included a mnemonic, a workshop to teach teamwork and communication skills, a role-playing session, and a sustainability campaign to educate resident physicians in handing over. The campaign, intended for process and culture change, included a logo, poster, and other materials to ensure program adoption. Implementation of the I-PASS program was associated with improvements in communication. Although bundling different tools appeared to have been effective, it prevented from determining which elements of the program were actually essential and why (Starmer, et al., 2014).

A	Analgesie Sedatie, psyche, delierbehandeling
A	Antibiotica Indicatie, stopdatum, SDD
N	Naasten Familiëgesprek
D	Dieet Voeding, maagretentie, ontlasting
A	Actuele medicatie Antistolling, immunosuppressiva, spiegelcontrole
C	Centrale lijnen Indicatie, insteekopening
H	Houding Mobiliseren, decubitus, wonden, revalidatie
T	Trials Inclusie, toestemming gevraagd?

Figure 5: AANDACHT mnemonic used at LUMC.



Figure 6: Redesigned handover room (UMCUtrecht, 2017).

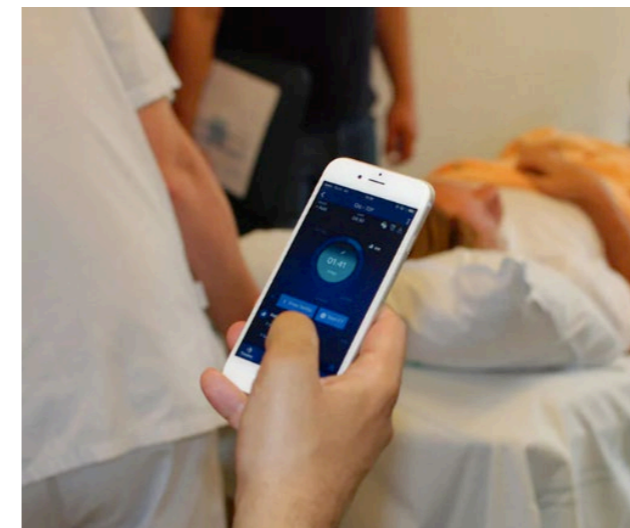


Figure 7: Philips stroke communication tool (Philips, 2019).

Different mnemonic tools

Mnemonic tools facilitate structuring of information and avoid the omission of relevant data. One of the most widely accepted and used tools is the SBAR mnemonic (Situation, Background, Assessment, and Recommendation) (Sirgo Rodríguez, et al., 2018). This tool is intended to structure information and optimize effective communication. For example, by using the SBAR tool nurses could be empowered to properly formulate a recommendation to a doctor (De Meester, Verspuy, Monsieurs, & Van Bogaert, 2013). A mnemonic used during at LUMC is the ‘AANDACHT’ mnemonic (Figure 5). However, it can be argued that despite mnemonic tools may help provide clarity, they will not suffice to facilitate co-contruction of understanding of the patient as it only facilitates structured one-way communication. Moreover, little empirical evidence has shown that these tools will lead to better continuity of care, efficiency, and safety (De Meester, Verspuy, Monsieurs, & Van Bogaert, 2013).

Redesigned handover room

UMC Utrecht has developed a new handover room where modern technology is cleverly applied to optimally support information exchange between care providers during MDTs. Most important is the oval table situated in the middle of the room, which has built-in displays giving access to all patient data, such as radiology images and the EMR. Furthermore, the new MDT room makes it possible for specialists from all disciplines to be physically present or remotely involved in the discussion of treatment plans of the patients by a video conference. Their expectation is that this redesigned room will save a considerable amount of time and will result in a decrease in medical errors. Nonetheless, the effect of the newly designed room has not been studied yet (UMCUtrecht, 2017) (Figure 6).

Philips stroke communication tool

Philips is developing the ‘stroke communication tool’, an app supporting communication between different medical professionals from different hospital departments. When a person suffers a stroke acting fast is necessary. Communicating the patient’s information in a timely manner within a large medical team is often not efficient, which means that a stroke patient can not optimally be treated yet. The communication tool is an app that promises to enable swift, transparent, and real-time information sharing among the hospital staff and the acute stroke team (Figure 7). The app is designed to provide easy access to all necessary information: test results, imaging, medication overview, where the patient is in the care flow, next steps, and a messaging service for the care team to use with another. The aim is that everyone involved can have the right information at the right time, but as the communication tool is not on the market yet, the effectiveness has not been proved yet (Philips, 2019).

Patient information sheet and pocket cards

A one-page patient information sheet that provides basic patient information can be used to support handovers. The format proposed by Mascioli, Laskowski-Jones, Urban, & Moran (2009) aims to inform nurses about any important events or changes in the patient’s condition while being away from the unit. Additionally, pocket cards were designed to remind the nurse to obtain several vital signs and to prepare for a meeting with a doctor. Better preparation for a meeting with the doctor would give the nurse more confidence to ask questions. The sheet and pocket cards were designed for nurses from patient escort and the radiology department. A difficulty with these newly designed tools and techniques in this situation was that using them required a change in nursing practice, which is very difficult to realise (Mascioli, Laskowski-Jones, Urban, & Moran, 2009).

4.0 | FIELDWORK

Within a hospital context, user involvement in the design process can help designers to understand how activities are performed. Involving the users, in this case ICU doctors and nurses, early in the design process can assist in capturing their real needs (Caixeta, Fabricio, & Tzortzopoulos, 2013).

This chapter shows the different activities that were done within the ICU context to reveal the experiences of the ICU team regarding their handovers. To become familiar with the ICU context, the organization of handovers, and the activities of ICU staff, many observations were done. Additionally, interviews led to deeper insights into people's own experiences with the handover moments. Both activities resulted into three ingredients including the obtained insights which need to be considered while designing for enhanced patient handovers.

- 4.1 Observations
- 4.2 Interviews
- 4.3 Conclusion

4.1 OBSERVATIONS

Already in an early phase of the project, different observations were done. These observations included attending different handover moments, and also accompanying the doctors and nurses throughout their day shifts. Furthermore, observations at Erasmus Medical Centre (EMC) were done as well. The main research questions to be answered were:

- What does a day of an IC doctor look like?
- What does a day of an IC nurse look like?
- Which handover moments exist at the ICU at the LUMC and how are they organized?
- Which barriers can already be identified?

4.1.1 Approach

The aim of the observations was to understand and interpret the behaviour of the ICU team throughout the day and during handovers, for example the way they move and interact. Mainly unstructured observations were done. This means that the method of observation and/or the behaviours of interest were not defined prior to the study (Mulhall, 2003). Simply field notes on the behaviour of the doctors and nurses were made. Entering the field without predetermined notions allowed for being open to every kind of behaviour, which suited this study as it had an exploratory nature. To execute the observations, different roles were taken on (Mulhall, 2003):

► The observer as participant:

This role was taken on when observing the different handover moments throughout the project. When being this role, the ICU team knew that I was observing handovers in order to improve them. I had some interaction with the ICU team, but this was limited as I wanted to stay as neutral as possible.

► Participant as observer:

This role was taken on when shadowing doctors and nurses for a complete day. While being dressed in a white coat, accompanied by a doctor or a nurse, I observed what a day of a doctor and a nurse looks like, with a focus on the handover moments. Moreover, I was involved in all their central activities. As the people at the ICU already knew me, my role as observer was also known by them.

► Complete observer:

This role was mainly adopted when I was sitting behind the nurse's desk and anonymously walking around units to observe where everyone is located and how people moved within and around the units. Most doctors and nurses were unaware that I was observing them in this case.



Figure 8: Me as 'participant as observer'.

4.1.2 Results

The observations provided insights in the interactions between doctors, between nurses, and between both groups. Furthermore, it illustrated a holistic picture of an ICU, captured the structure of a day shift, the structure of the different handover moments, and informed about the influence of the physical environment. Accompanying the doctors and nurses throughout their day shift clarified which activities they do and allowed to connect with them and their colleagues.

The obtained results were captured in four different models: a timeline, a sequence model, a flow model, and a physical model. These models represent my own observations within the ICU setting at the LUMC.

Timeline

First of all, a 24-hour timeline was created based on the observations (Figure 9). The timeline shows the different handover moments of both doctors and nurses during the day, evening, and night shift. During a day shift, two groups of one intensivist, one fellow, and two residents are working at both units. The nurse-patient ratio is usually 1:1. During the evening and night shift, way less members of the ICU team are present. Only one group of doctors is present, and the nurse-patient ratio is often 1:2.

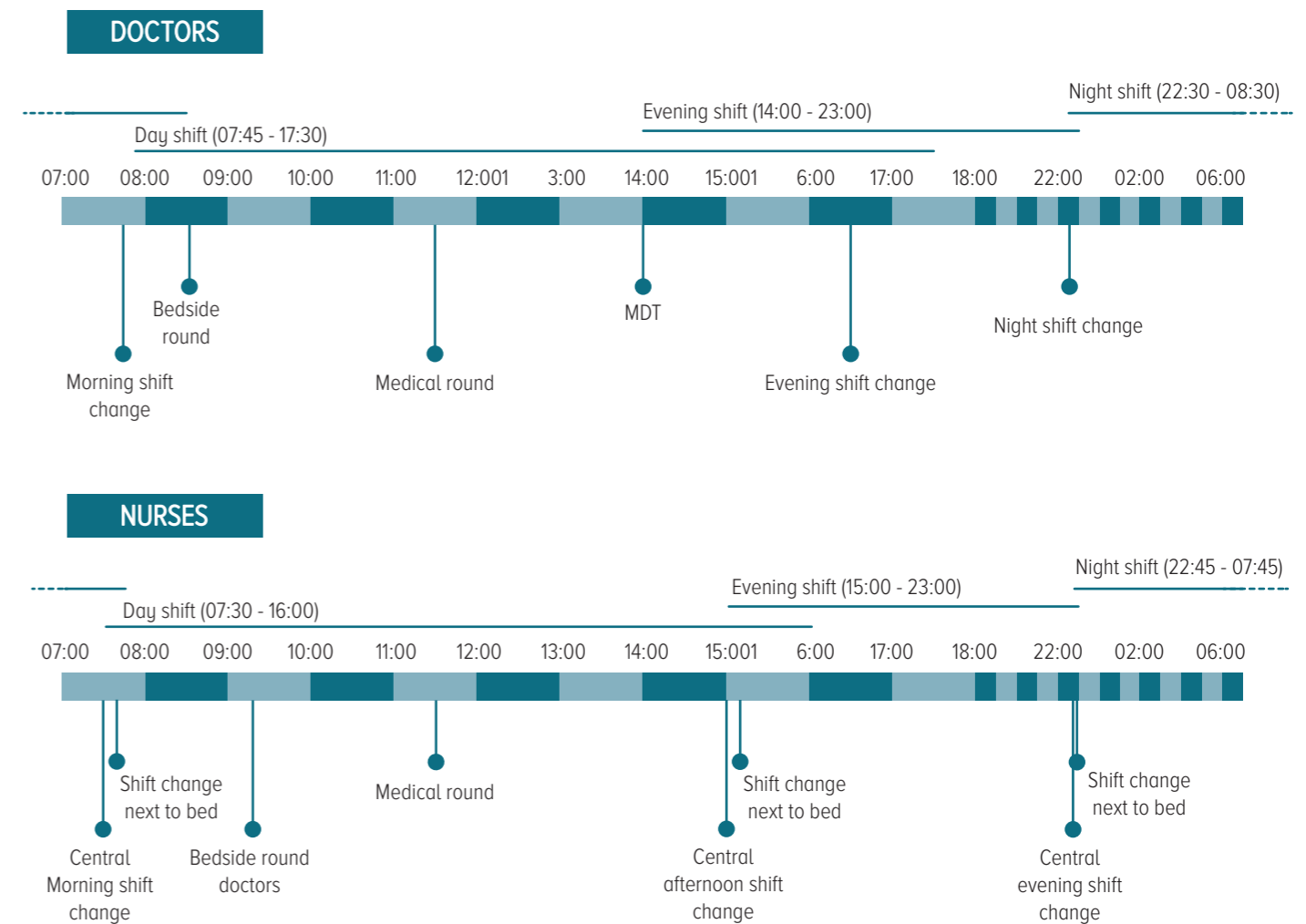


Figure 9: Timeline representing 24 hours of a doctor and a nurse

4.1.3 Observations Erasmus MC

Besides only observations at the LUMC, also observations at the EMC in Rotterdam were done. The goal of this one-day visit was to compare the ICU at LUMC with the ICU at EMC with regard to their way of internally handing over patients. The Thorax ICU and the regular ICU were visited, accompanied by an intensivist. All the handover moments that are included in a dayshift were observed. Furthermore, the intensivist was shadowed during his activities throughout the day.

By talking to the IC staff, it was discovered that the ICU at Erasmus had similarities as well as differences compared to the ICU at LUMC. A table explaining these similarities and differences can be found in Appendix C.

In summary, there were quite some differences regarding the patient handovers when comparing both hospitals. The most obvious difference was organization of the handover moments. At the LUMC, two more handover moments compared to the EMC exist, as the EMC merged the medical round and bedside round, as well as the MDT and evening shift change. From my point of view, merging those moments really contributes to the efficiency of a shift, as there is more time left to spend with and around the patients. However, a disadvantage of merging them is that the actual handovers might be experienced as less efficient, because they take slightly longer compared to LUMC. However, eventually quite some time is saved by organising less handover moments, which is the reason why I advocate EMC's handover schedule.

Another difference I noticed is the usage of artefacts to support handovers. At LUMC, different (self-invented) artefacts are used as memory aids (Figure 13). At EMC, one ready-made handover sheet including all relevant patient information is provided to everyone (Figure 12). I think providing a patient information sheet is very useful, as this saves quite some writing time, allowing the ICU team to listen better during handovers. Moreover, the overview provided by EMC looks very structured and can be read beforehand, resulting in being well-prepared. The only disadvantage of this paper overview is the higher chance of data leaks it involves. All in all, the observations at Erasmus MC allowed for a fresh, eye-opening perspective on the way handovers are organized within a hospital. The key takeaway is that the way handovers are structured throughout the day at the LUMC is definitely not a fixed structure, and that other schedules and set-ups of handovers are possible as well within an ICU setting.



Num	Patient	RuO / Diagnose	Huidige problematiek	Beleid
4	IC/CTIC	VG CVA wv coagulogram, DM2, HT, HC	DB 10 CABG 3x ebn stabiele AP over 3 VO	AS: Clopidogrel AB: mapi, cefazoline
5	IC/CTIC	VG CVA wv coagulogram, DM2, HT, HC	DB 10 CABG 3x ebn stabiele AP over 3 VO	AS: Clopidogrel AB: mapi, cefazoline
7	IC/CTIC	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
9	IC/CTIC	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
11	CAR/CTIC	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
12	CAR	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
13	CAR	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
14	CAR	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:
15	CAR	VG Hoofdpijn, multivitaminen, HT	DB 10 CABG bij ZVD en HSS	AS: Acetol, netro AB:

Figure 12: Handover sheet used at the EMC.

Figure 13: Each doctor and nurse working at the ICU within the LUMC has an own documentation style.

RAPIDPoint® 500	
ARTERIAL SAMPLE 17.09.2019 12:30 System ID 0500-32984	
Patient ID LSE Name Operator	
ACID/BASE 37.0 °C	
pH	7.452
pCO ₂	4.35 kPa
pO ₂	9.93 kPa
BE(O) act	22.3 mmol/L
BE(B)	-0.9 mmol/L
CO-OXIMETRY	
Hct	0.39
SpO ₂	8.3 mmol/L
sO ₂	93.1 %
FO ₂ Hb	86.9 %
FC ₂ Hb	6.5 %
FMetHb	0.2 %
FIHb	6.4 %
ELECTROLYTES	
Na ⁺	138.7 mmol/L
K ⁺	3.92 mmol/L
Ca ⁺⁺	1.22 mmol/L
Ca ⁺⁺ (7.4)	1.25 mmol/L
Cl ⁻	101 mmol/L
METABOLITES	
Glu	5.7 mmol/L
Lac	1.07 mmol/L

4.2 INTERVIEWS

A second step of the field research was doing interviews in order to get a deeper understanding of the ICU team's attitude towards and experience with the different handover moments. Interviews with ICU doctors as well as with ICU nurses were executed. The main research questions were:

- How do ICU doctors and nurses experience the different handover moments?
- Which pain points are encountered by ICU doctors and nurses relating to handovers?

The interviews facilitated that doctors and nurses could express what their values and needs are and most importantly, why they have these values and needs. Collecting insights into these deeper layers required that the participant had been involved in the situation for some time. Therefore, the interviews were based on sensitizing materials (Sleeswijk Visser, Stappers, van der Lugt, & Sanders, 2005).

4.2.1 Approach

Participants

Selecting the appropriate people to participate is critical to the success of the project, since the design process can significantly be affected by the insights these people from the medical field provide (Caixeta, Fabricio, & Tzortzopoulos, 2013). To get a proper view on the needs of the ICU team, it was decided to involve different doctors as well as nurses into the interviews. The team leaders of the ICU units helped with recruiting the participants. Eventually, two intensivists, two fellows, two residents, three nurses from IC unit 1-2, and three nurses from IC unit 3-4 were recruited for the interviews (Table 1). The participants varied in age (29-64 years old) and gender (half male/half female).

Sensitizing

A few days in advance of the interview, the participants received a workbook to immerse themselves into the subject of handovers, and to recall memories, associations, and stories (Sleeswijk Visser, Stappers, van der Lugt, & Sanders, 2005). The insights obtained when doing the observations were used to create the sensitizing materials, thereby it was ensured that the workbook was not about subjects already

known, but already allowed for more depth. For example, time lines with the day schedule and pictures of artefacts used during handovers were inserted and questioned. Besides exercises about handovers, the scope of the content was a bit broader. For example, general questions about working at the ICU were inserted as well.

The sensitizing package included a sensitizing booklet (Figure 14), a lollipop, and a pen. The booklet of the nurses slightly differed from the booklets of the doctors, as both groups have a different daily routine (Appendix D).

Interview Procedure

The interviews were all held at the ICU in one of the available offices. During every interview, the sensitizing booklets were discussed with the participants, in order to be able to dive deep into the different subjects. The interviews were semi-structured, as this offered to have a clear focus, but simultaneously guaranteed for flexibility. Every interview lasted between 30-55 minutes. All interviews were recorded and transcribed afterwards. The transcripts were used for data analysis and thereby identification of themes and patterns.

The complete interview script and consent form can be found in Appendix E.

	FUNCTION	AGE	GENDER
1	Intensivist	54	Male
2	Intensivist	43	Female
3	Fellow	34	Male
4	Fellow	36	Male
5	Resident	29	Male
6	Resident	30	Female
7	Nurse unit 1-2	57	Female
8	Nurse unit 1-2	38	Female
9	Nurse unit 1-2	47	Female
10	Nurse unit 3-4	64	Male
11	Nurse unit 3-4	29	Female
12	Nurse unit 3-4	44	Male

Table 1: Interview participants

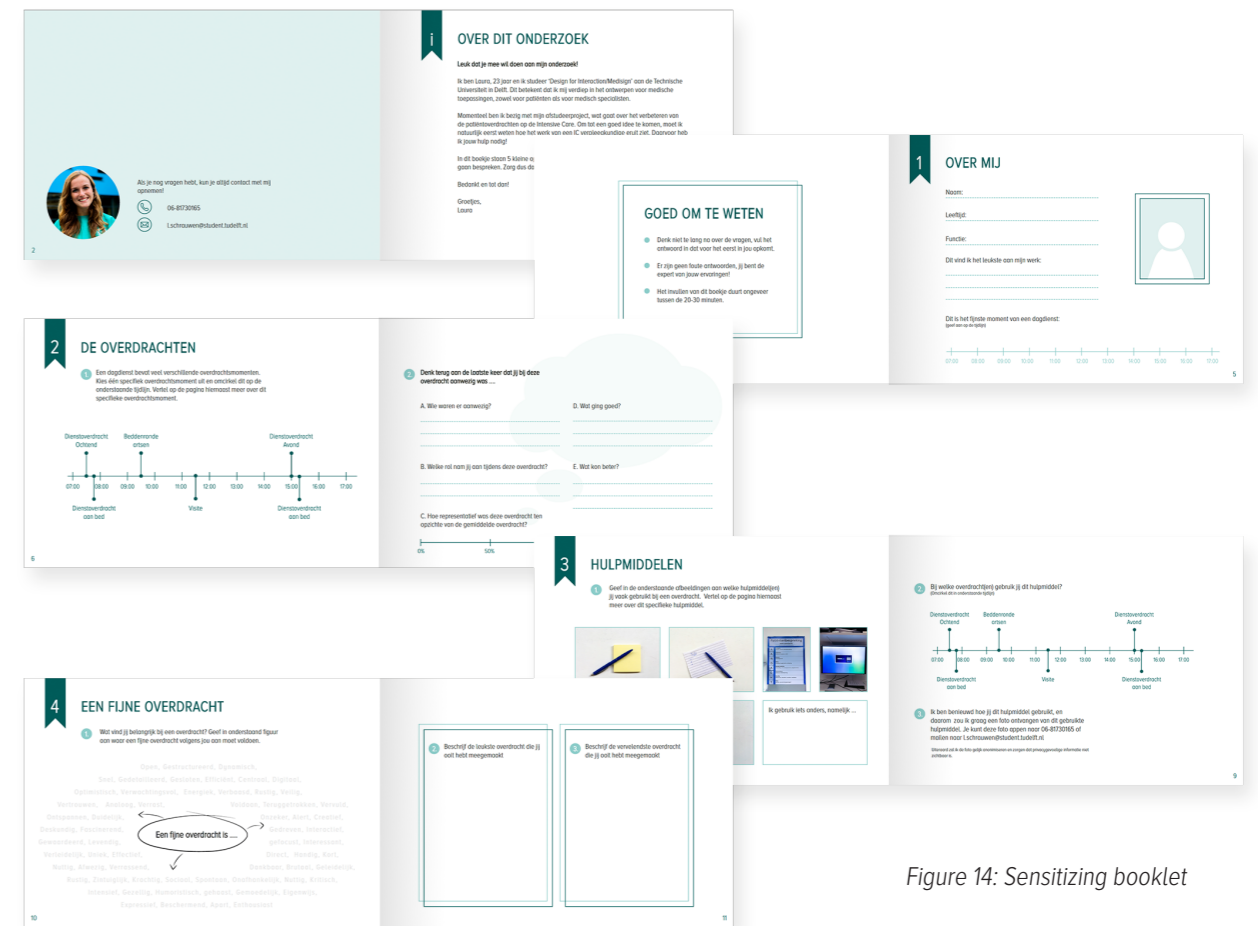


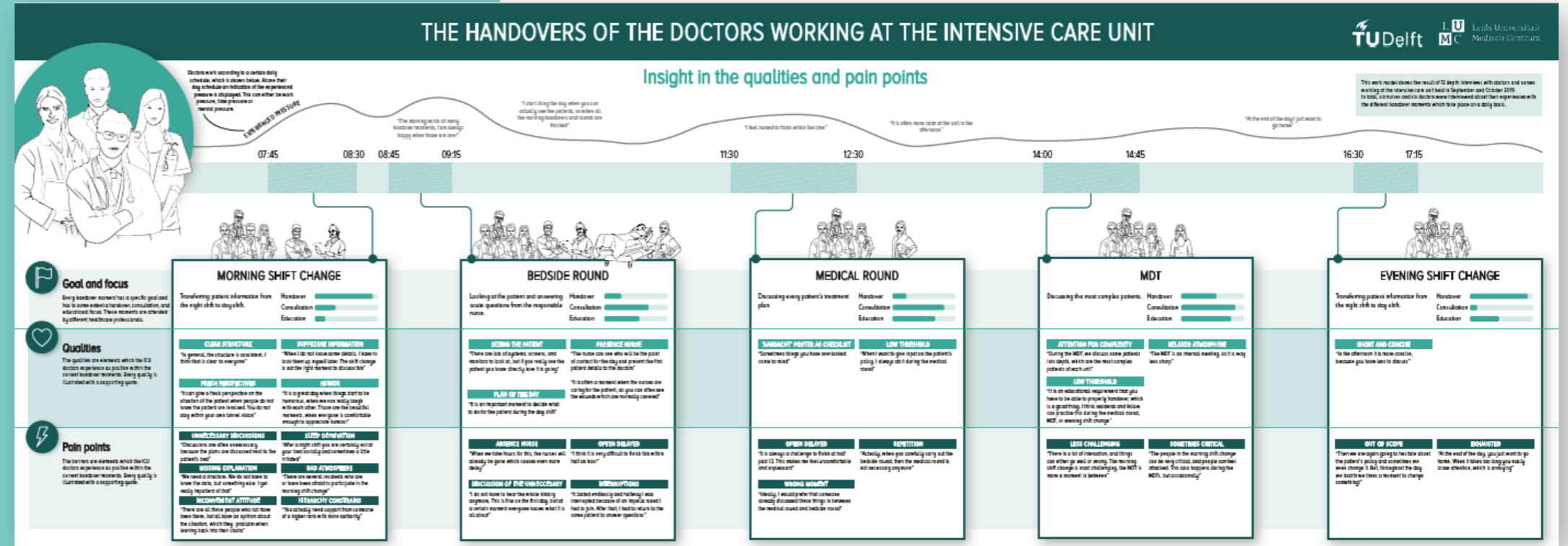
Figure 14: Sensitizing booklet



Figure 15: impression of the interviews.

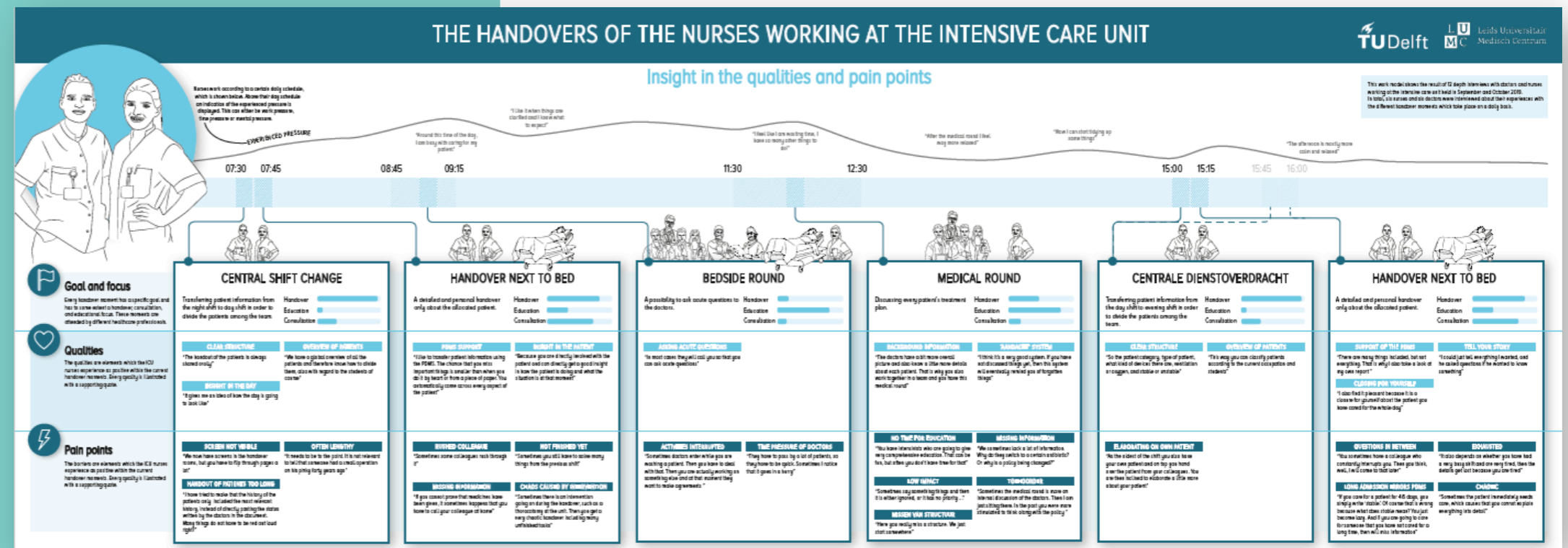
▶ FIGURE 18: THE HANDOVERS OF THE DOCTORS WORKING AT THE INTENSIVE CARE UNIT
Insight in the qualities and pain points

The full, readable poster can be found on the sheets added to this report.



▶ FIGURE 19: THE HANDOVERS OF THE NURSES WORKING AT THE INTENSIVE CARE UNIT
Insight in the qualities and pain points

The full, readable poster can be found on the sheets added to this report.



4.3 CONCLUSION

All in all, the fieldwork including observations and interviews led to a complete understanding of the ICU, with a focus on the handovers. Altogether, ten main insights can be listed, divided into three ingredients offering opportunities for improvement: *information sharing*, *team dynamics*, and *context*. Comparing these insights with the insights obtained during the literature search, a relation with the communication failure factors found in the literature search can be found (Figure 20).

The insights under the ingredient ‘*information sharing*’ are related to psychological and mostly to educational factors, because differences in information sharing and expectations most likely occur due to differences in education, but are influenced too by the differences between the ICU teams.

The insights relating to the ingredient ‘*team dynamics*’ mostly belong to psychology but are influenced by the organizational factors as well, for example because a lack of interaction between doctors and nurses may also be caused by the organization of the handover rooms.

The ingredient ‘*context*’ including the three insights directly belongs to the organizational factors, but is also influenced by differences in education, for example, the terminology used in the PDMS is different for doctors and nurses because they use different medical terminology.

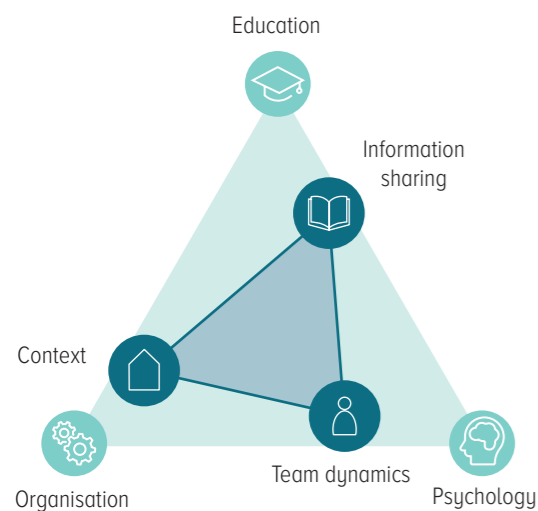


Figure 20: Relation between insights found in literature and insights found during fieldwork.



INFORMATION SHARING

1. **Every handover moment has a specific goal, but everyone attending has a (slightly) different interest or expectation of being there.**
Being unaware of others’ interests can result into useless discussions, irritation, and even friction between the different people attending. Moreover, this often results in sharing of ‘irrelevant information’: information that the receiver does not need at that moment.
2. **Nurses feel that they are sometimes missing background information relating to the medical procedures they have to execute.**
Some of them wish to know more in order to feel more included and more assured within the team around a patient. Moreover, this is the reason why they value their occasional MDTs a lot.
3. **Structure versus flexibility**
It became very clear that sharing information in a structured way is important for each handover moment. Without the message being structured, it is difficult for the receivers to (thoroughly) understand each patient. However, there exists a strong desire for flexibility in this as well, as the ICU team believes it is not possible to capture each patient within the same communication structure.



TEAM DYNAMICS

4. **The existing hierarchy within the hospital influences each handover moment a lot.**
People from ‘lower hierarchies’ feel that they need verbal support from ‘higher hierarchies’. Furthermore, they tend to step more into the background when many ‘higher hierarchical’ people are present. This strongly influences the dynamics of each handover moment, which can either be a positive or negative phenomenon (positive when higher hierarchies can stand up for others, negative when people from lower hierarchies tend to stay in the background).
5. **Though teamwork is valued the most by the ICU staff, still a gap between them is present.**
Both the group of doctors and the group of nurses feel like a separate body of the ICU to some extent.
6. **There is a lack of interaction between the doctors and nurses during their joint handover moments.**
However, the nurses wish to have more interaction in order to contribute more to the treatment plan of their patient.
7. **Old customs and current changes set the atmosphere of some meetings**
Think of each persons’ different background (for example in the morning shift change of the doctors) and the fact that the different IC units were merged a few years ago.



CONTEXT

8. **The physical environment has a strong influence on each meeting**
This includes the location of the computers, table, chairs and central screen. Furthermore, the availability of several artefacts can determine the content of a meeting (for example the posters hanging in the handover rooms).
9. **The PDMS plays an important role within the handovers from both doctors and nurses but is not optimally designed.**
Complains about the readability, the connection with other systems used by the hospital, and copy-paste behaviour regarding the documentation were heard frequently.
10. **Doctors feel time pressure in order to finish each handover moment within the desired time.**
The nurses notice their pressure and feel that they can sometimes be rushed, but they comprehend it as well.

5.0 | DESIGN BRIEF

This chapter describes how the insights from the field study assisted in sharpening the design goal and creating a design vision. The design vision is supported by potential concept directions based on the desired impact I can make within the given amount of time of this project. Furthermore, design considerations based on literature, fieldwork, and the design vision were made. These considerations can be seen as the starting point for design.

- 5.1 Design goal
- 5.2 Design vision
- 5.3 Evolution instead of revolution
- 5.4 Design considerations

5.1 DESIGN GOAL

Referring to the main question to be answered during this project, “How can we achieve that the patient handovers are experienced as effective and efficient, and simultaneously realize a better shared understanding of patients’ needs among the ICU team?” and the insights and design ingredients obtained in the field study, it was concluded that the eventual design should be a holistic solution, meaning that the design should focus on both ICU doctors and nurses and on all their handover moments. Focusing on only one group or handover moment would probably not lead to a proper solution, as each handover or meeting is influenced by the one before that, and since the meetings are intra- as well as interdisciplinary, both ICU doctors and nurses should be seen as the main target group for this design challenge. Therefore, the design goal turned out to be a direct translation of the main research question:

My design goal is to achieve that the patient handovers are experienced as effective and efficient, while simultaneously realizing a better shared understanding of patients’ needs among the ICU team

Patient handovers include all the scheduled moments of information sharing between the ICU team. These moments include the shift changes (day, evening, night), bedside round, medical round, and MDTs. Handovers intended for department change or hospital transfer are not within the scope.

Effective means that the handover should be successful in transferring the right and relevant patient information.

Efficient means that the handovers can be finished within a limited timeslot.

Achieving a *shared understanding of patients’ needs* is the main goal of a handover but is also most challenging as the ICU includes a wide variety of complex patients with different needs.

The *ICU team* includes the team of doctors and nurses working at the ICU

The word *experience* was added later to the design goal, as the eventual goal is not to measure whether the handovers have become more effective and efficient in sense of evaluating for example treatment mistakes, but key is that each member of the ICU team will obtain a sense of effectiveness and efficiency when attending a patient handover.

“FACILITATE THAT DOCTORS AND NURSES AT THE ICU CAN PRACTICE THE ART OF HANDING OVER.”

5.2 DESIGN VISION

Looking back at the different activities in the analysis phase, a vision for design could be constructed and potential directions for future design could be identified. The insights obtained during fieldwork formed the basis for the construction of this design vision.

Metaphors can help designers to understand design problems by comparing them with known situations. Approaching the project from a different perspective might enhance creative thinking (Casakin, 2007). Therefore, it was chosen to correlate the work of artists with the work of ICU doctors and nurses. The following design vision was constructed:

It is a fact that patients admitted to the ICU differ a lot from each other, and that various medical professionals with different qualities, personalities, and viewpoints are involved in the handover process. You cannot change that. Therefore, you have to embrace what you cannot change, and design what you can change, which are the tools used for handovers, in this case: The easel, canvas, brushes, and palettes used to co-construct a picture of each patient. Therefore, I envision to design a tool that assists ICU doctors and nurses to practice the art of handing over: Only sharing patient information that is important and relevant regarding the specific handover moment and thereby carefully taking the personal interests of each attendant into account. Thereby, making these medical meetings feel effective and efficient for everyone.



Figure 21: Design vision.

5.3 EVOLUTION INSTEAD OF REVOLUTION

As I aimed to create a tool that could be used in the here and now, an overview of the different concept directions that are possible within a certain amount of time was created (Figure 22). Since this graduation project has to be finished within a limited amount of time, designing 'a tool' seemed to be the most impactful direction to continue with. However, as can be seen in Figure 22, in the future it might be possible to create solutions as a new, advanced PDMS, a redesign of the ICU organization, or a new building layout with optimally designed handover rooms. But for this project, the current PDMS, handover schedule, and the physical environment of the LUMC were taken for granted. The aim was that the design should seamlessly fit within these boundaries in order to create most impact within the given amount of time.

So, for this project, by designing to improve the patient handovers, I strove for an evolution instead of a revolution: Working with small instead of significant changes.

5.4 DESIGN CONSIDERATIONS

Based on the obtained insights by literature, the fieldwork, and the design vision, design considerations could be made. First of all, as I was looking for a holistic solution it was required that the eventual design is created for ICU doctors as well as for ICU nurses. This also included that each handover moment should be taken into account within the design. Secondly, also related to the desired holistic character of the eventual solution, it was important to take each ingredient found into account when developing a concept, so 'information sharing', 'team dynamics', and 'context'. Fourth, referring to the impact I can make as explained in the previous subchapter, it was crucial that the eventual solution would be in line with the current workflow of the doctors and nurses. Lastly, I personally believed that was essential to respond to the fact that some members of the ICU team do not always feel heard because of the existing hierarchies and the existing lack of interaction between doctors and nurses. Explicitly considering this issue as well in the design might lead to better team dynamics and thereby to improved patient handovers.

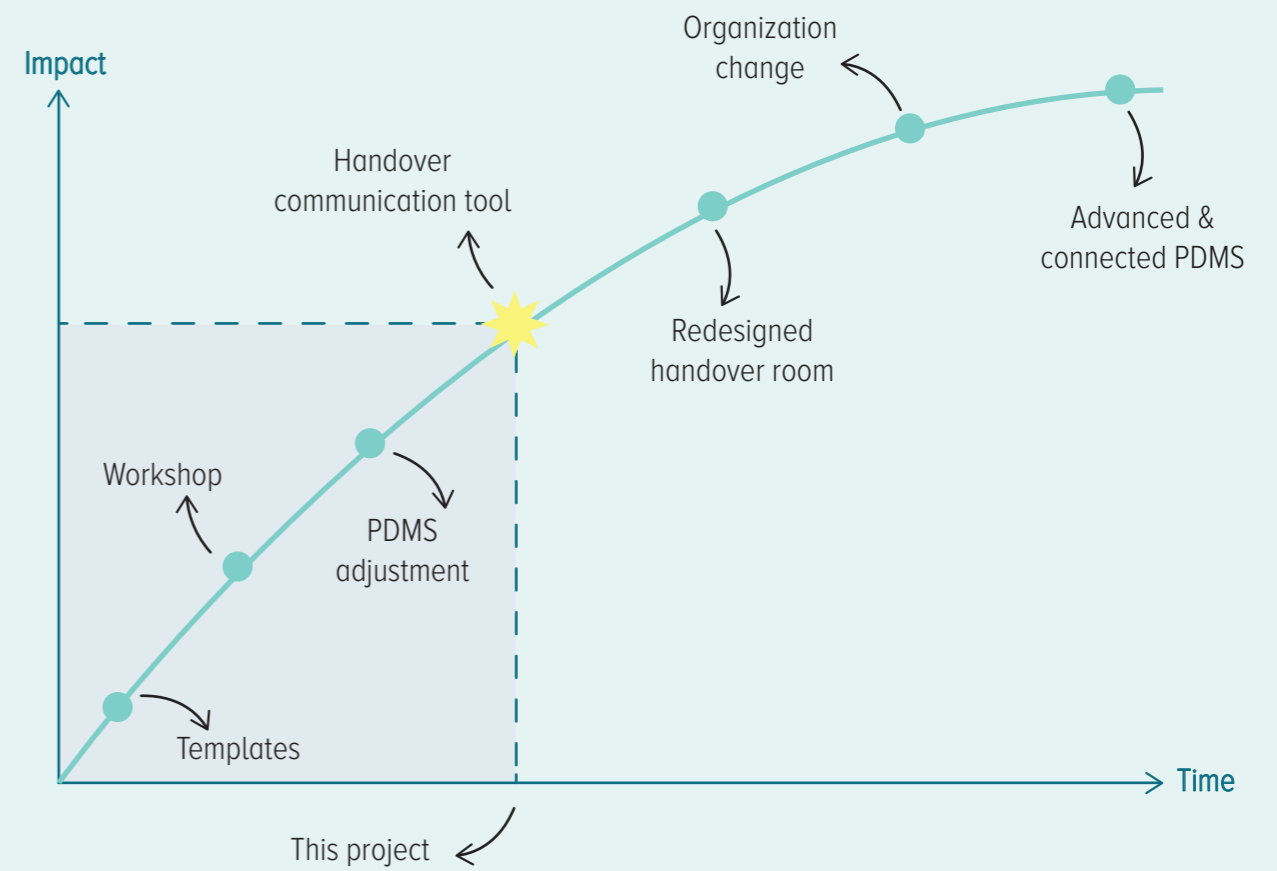


Figure 22: The possible directions based on impact and time

6.0 | CONCEPTUALIZATION

This chapter describes the different activities and involvement of the ICU team throughout the conceptualization process resulting, into the final design. These activities included a creative session with IDE students, consulting the PDMS expert, concept validation with the ICU team, and a session with the ICU team. Each of these activities contributed to the design of a final concept that is in line with the previously described design goal, vision, and considerations.

- 6.1 Creative session with IDE students
- 6.2 Consultation PDMS expert
- 6.3 Ideation based on fieldwork
- 6.4 Concept validation with ICU team
- 6.5 Session with the ICU team

6.1 CREATIVE SESSION WITH IDE STUDENTS

Already in an early phase of the project, a creative session with Industrial Design Engineering (IDE) students was joined, which was facilitated by the IDE master elective 'Creative Facilitation'. This session was done before the fieldwork was done and before the design vision was defined. Therefore, the results of the session are not related to the insights obtained but are mostly for inspirational purpose.

6.1.1 Approach

Two groups of six students, each group including one facilitator, participated each in a creative session. The goal given to the participants was to come up with concepts aiming to improve the patient handovers in a way that managing patient care becomes more efficient and effective. The participants brainstormed for 2.5 hours on the subject and used different creative facilitation techniques (Tassoul, 2009).

6.1.2 Results

Multiple rounds of brainstorming eventually resulted in four different concepts. These concepts were focused on involving the patient in the handover process, layering information, digitalizing the handover process, and remembering handover information by heart. The generated concepts were used for an inspirational purpose.

6.1.3 Conclusion

Organizing a session together with the students from Creative Facilitation was a great and inspiring opportunity. As the session already took place in the second week of this graduation project, it kickstarted the ideation process in an early phase. The enthusiasm of the students working on the design case gave me lots of positive energy as well. However, as the session took place before the fieldwork was done, the results are not related to the obtained insights during the study and are therefore mostly for inspirational purpose. Though, some elements of these concepts can be interesting for further design, for example the fact that the patient was involved in concept 1. Can something like this also be created to involve the ICU team more with each other? Moreover, concept 4 was a great example of making the handovers more structured in a very fresh and positive way. The positive energy of this concept was something that is aimed to be expressed in the final design as well, as this positive energy can probably support the team dynamics within the ICU team.

Figure 23: IDE students brainstorming about enhancing handovers

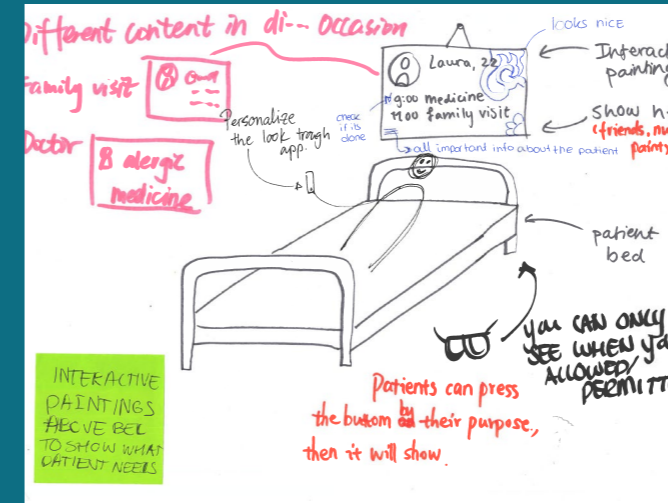


Figure 24: Concept 1, the painting

Concept 1: The painting

The painting shows the medical patient information in a relevant way for the viewer. The painting can detect whoever is watching and based on that it adjusts the data and layout that can be viewed. In this way, patient information is always available at any time for the medical professionals, and important details for the family are provided as well (Figure 24).

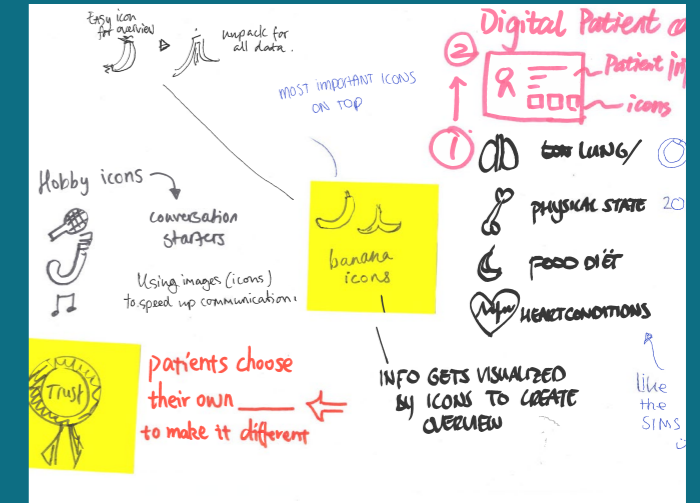


Figure 25: Concept 2, information layering

Concept 2: Information layering

This concept explores how to deal with lots of information, specifically layering the information. The concept proposes different digital icons in which information can be stored. As the icons serve as metaphors as well, information can intuitively be found by the ICU team. (Figure 25).

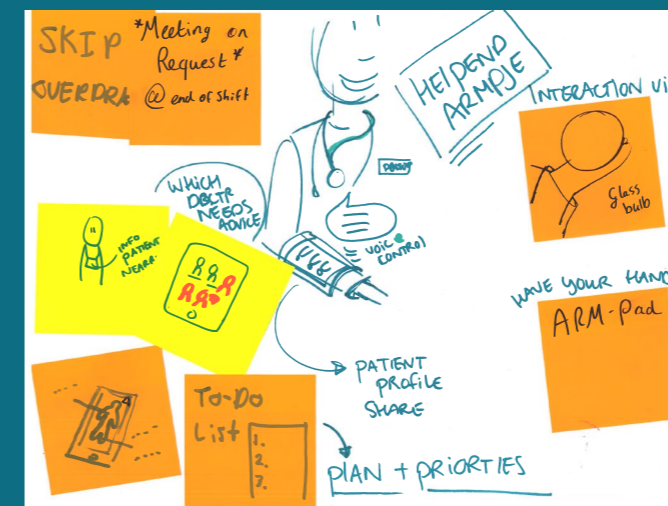


Figure 26: Concept 3, the helping arm

Concept 3: The helping arm

The helping arm is a wearable intended to support patient handovers in a digital way. Since all patient information is always visible, and since the whole team can be contacted through this wearable, physical meetings will take less time or are not necessary at all anymore. As the wearable bends over the arm, the doctor or nurse still always has both hands free to carry out other work simultaneously (Figure 26).



Figure 27: Concept 4, the handover song

Concept 4: The handover song

The handover song is a concept assisting the ICU team to remember the most important patient details. Based on the patient's data and a standard song format, an algorithm creates a song based on each patient's medical data. Since it is a song which is easy to remember, the doctors and nurses will remember this data effortlessly throughout their shift (Figure 27).

6.2 CONSULTATION OF PDMS EXPERT

Since it is crucial that the eventual solution is in line with the current workflow of the ICU doctors and nurses to make optimal impact within the given amount of time, the PDMS expert was consulted to make an inventory of the adjustment possibilities of the current system. This could stimulate ideation about potential concepts connected to this system.

MetaVision

Currently, the PDMS makes use of the software 'MetaVision'. This software package offers a PDMS which is specifically designed to support the doctor and nurse with patient information at critical care departments. It contains many options to integrate the system into the complete IT landscape of a hospital (Itémedical, n.d.). According to the expert, MetaVision is a very suitable system for the ICU, as it can present and communicate a lot of patient and medical device data in a certain layout. In other hospital departments, a more general EMR suffices to present patient data, in case of LUMC this is provided by HiX software. However, these EMRs do not respond to the demand of an ICU, most importantly, the possibility to present lots of patient and medical device data into one layout. Therefore, besides using HiX as EMR, additionally MetaVision was added to their IT landscape functioning as PDMS specifically designed for the ICU.

Current design of MetaVision

By exchanging some thoughts with the expert, it was discovered that it is possible to make various changes and additions to the layout of the PDMS. This includes adding and deleting parameters, overviews and tabs, and the possibility to connect the system to web pages. This offers interesting design opportunities, as the current PDMS interface is not optimally designed for handovers: It includes many letters and numbers which are not readable from a distance. On top of that, it includes lots of medical data on each page which is not relevant to show during handovers.

Using the existing software

Besides the opportunities for design, the expert also emphasized that software manufacturers in healthcare have a lot of power, which involves some design restrictions as well. The most important restriction is that switching software systems is very expensive therefore not possible. So, any design proposal which includes a PDMS should fit within their current software package.

6.3 IDEATION BASED ON FIELDWORK

When the analysis phase of the project was finished and the design goal and vision were constructed, it was possible to brainstorm about different concepts related to these insights. First, an elaborate brainstorm was done based on the design ingredients found (Figure 28). Then, a selection of the most potential ideas was made. This selection was based on

the connection with the different ingredients, insights, and variation within the individual concepts. Eventually, the selection resulted into four different concept proposals which can be found on the next page.

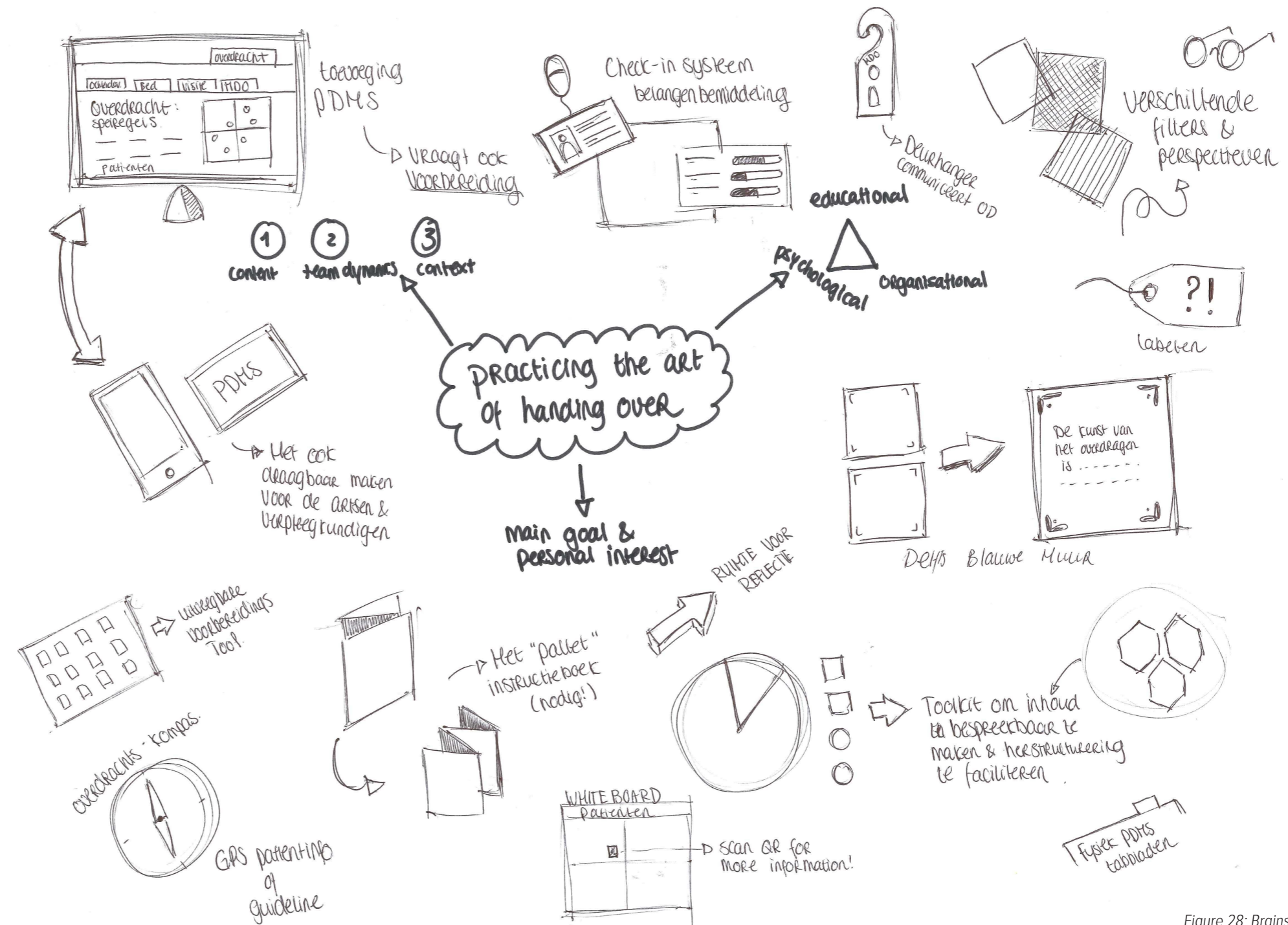


Figure 28: Brainstorm

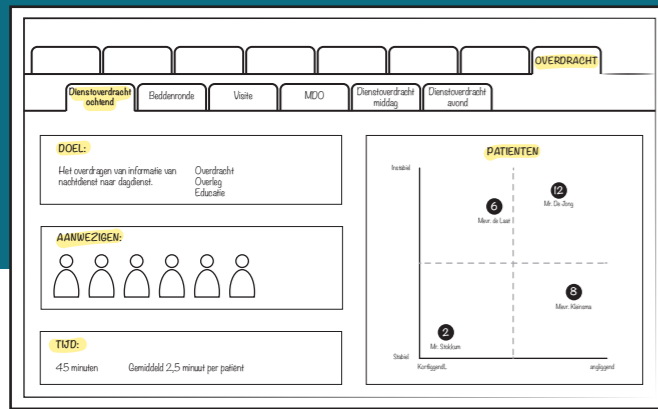


Figure 29: Concept proposal 1, PDMS extension



Figure 30: Concept proposal 2, handover guideline

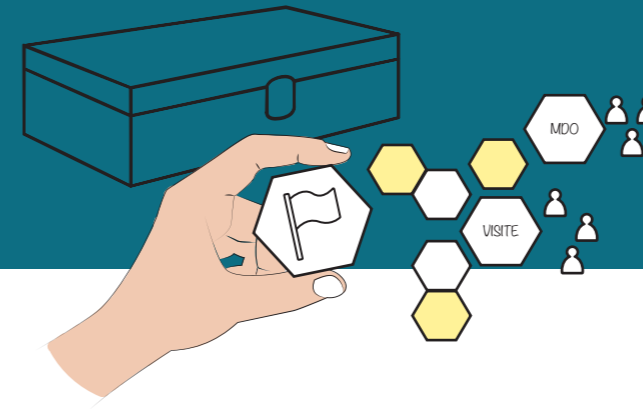


Figure 31: Concept proposal 3, reflection tool

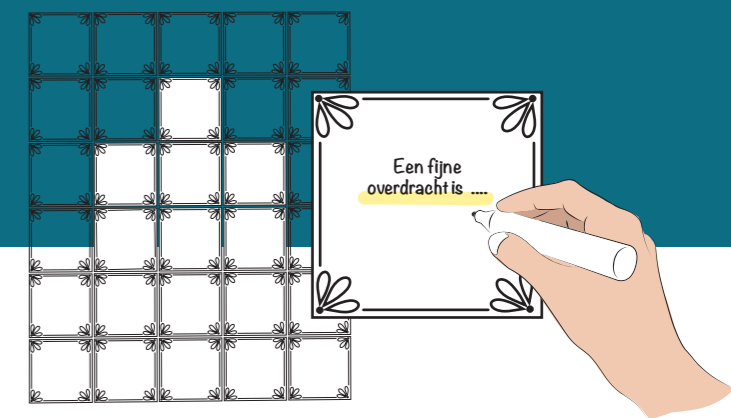


Figure 32: Concept proposal 4, vision wall

1. PDMS extension - Only presenting relevant data

This concept is an addition to the current PDMS (MetaVision) that is used at the LUMC. It is based on the insight that often too much information is shared and that the current PDMS does not support the handovers properly. To overcome these issues, it is suggested to add a 'handover' tab within the currently used PDMS interface. This page should only present data that is relevant for each particular handover moment. Besides that, an overview based on stability, duration of admission, and category of each patient is shown to give directly an indication of the complexity of each patient. Thereby, one can hypothetically better select which patient information is important to share. Furthermore, it makes sure that the language nurses and doctors are using to express patient complexity is better aligned (Figure 29).

2. Handover guideline – This is how we work

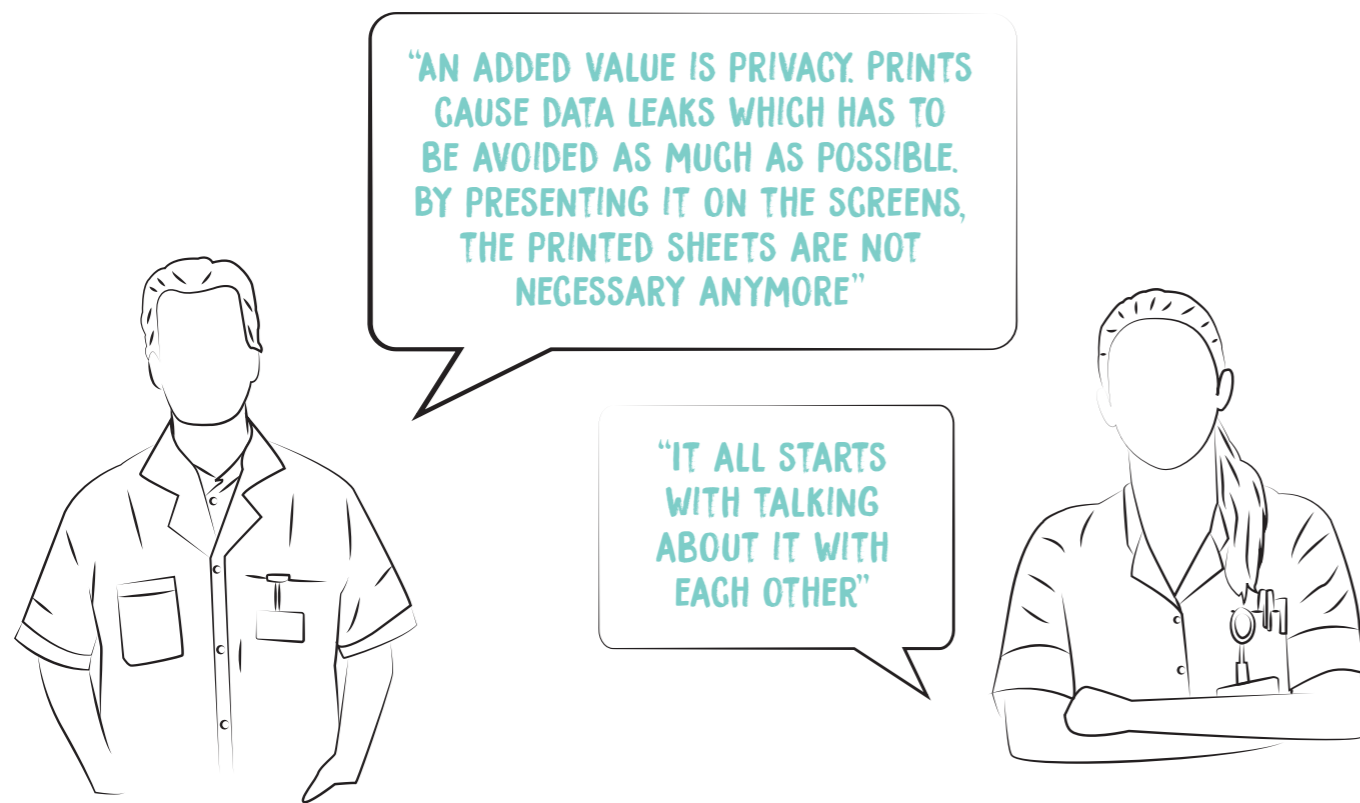
This concept is a general guideline of how the handovers should be organized at the LUMC. It is based on the insight that each handover has a specific goal but everyone attending has a slightly different interest. It manages the expectations of the attendees and also supports the ICU team's desire to have more structured handovers. The guideline aims to make the ICU team aware of each other's different interests and makes sure that wrong expectations are avoided. On top of that, it was discovered that a protocol, a document that is used in hospitals to communicate fixed procedures, does not yet exist for the handovers at the LUMC. The idea is that this tool is attractive to use, can be consulted when necessary, and assists the new people to easily learn how handovers at the ICU are organized (Figure 30).

3. Reflection tool – Reflecting and (re)organizing

The reflection tool assists and stimulates the ICU team to discuss and reflect on their handover processes regularly. This concept is based on the insights that nurses often feel they obtain too minimal information and that there exists a lack of interaction between both doctors and nurses. This tool allows the team to reflect how their handover processes are going and how they can improve them together. Is it still going well? What should be changed in order to respond to the team's demands? Moreover, it aims to facilitate proper communication of changes to the rest of the ICU team (Figure 31).

4. Vision wall – Being heard by your colleagues

The vision wall invites the ICU team to write down what they value and what they want to be improved at the ICU. Thereby, adapting to the need that especially the nurses need to get the feeling of being heard. This concept is based on the insight that there is a lack of interaction between doctors and nurses and therefore aims to improve the team dynamics. The eventual idea is to place this 'wall' in a handover room to raise awareness of values and complaints among the team. Simultaneously it serves as a decorative object (Figure 32).



6.4 CONCEPT VALIDATION WITH THE ICU TEAM

The concept proposals as explained in chapter 6.3 were discussed with ICU doctors and nurses. This revealed which direction for design would be most promising to focus on. The main questions to be answered for this study were:

- Which opportunities and obstacles can be identified per concept?
- Which core values does the ICU team have relating to a concept that aims to make their handovers more effective and efficient?

6.4.1 Approach

To evaluate the different concept directions, a quick but effective method to communicate the different concept directions to the ICU staff was necessary. Therefore, it was decided to put each concept a concept card (Page & Rosenbaum, 1992). Each concept card included a sketch showing how the concept could look as a product or service and a description of the main features and benefits. To clearly distinguish the different concepts from each other,

each card contained a different basis colour. The concept cards were discussed with five ICU nurses, five ICU doctors, and two interns. Each evaluation lasted between 15-30 minutes. During each conversation, the concept cards were shown one by one to each participant, who expressed his or her opinion about each concept. Eventually, the four cards were all put on the table allowing the participants to express their preferences and make combinations (Figure 34). During the discussions, notes were taken. A complete set-up of the evaluation can be found in Appendix F. The concept cards can be found in Appendix G.

6.4.2 Results

The ICU team enthusiastically gave lots of input on each concept and made comparisons between them as well. Table 2 which can be found in Appendix H presents a summary of the opportunities and obstacles per concept identified by the doctors and nurses.

Concept 1

All doctors and nurses agreed that concept 1 is promising with regard to the effectiveness of handovers. The visibility of the data is increased, and unnecessary clicking is prevented. The quadrant included in the interface would give the ICU team a global idea on how their day is going to look. For the nurses especially this proposal was interesting because it facilitates effective distribution of the patients among the team including students who cannot care for complex patients yet. Lastly, it was indicated by the nurses that privacy issues are tackled as it is not necessary anymore to print handover material, preventing data leaks. Points of attention for this proposal were amongst others that it should be avoided that this interface burdens the ICU team with lots of preparation and that the basic information presented is only suitable for the shift changes.

“I think it is very useful to make a presentation mode for the PDMS. However, you have to make sure that the presented data suits the kind of patient” – ICU doctor

“An added value is privacy. Prints cause data leaks which has to be avoided as much as possible. By presenting it on the screens, the printed sheets are not necessary anymore” – ICU Nurse

Concept 2

Concept 2 turned out to be the basis of structuring handovers and managing expectations of the complete ICU team. This detailed overview does not exist yet. It was mentioned that it should carefully be considered who is deciding on the content of this concept. Furthermore, it was mentioned by some doctors that a structure should not cause that the quality of the handovers decreases. Therefore, there needs to be a balance in freedom of communication and (too) detailed guidelines.

“It is important that a common perspective of the handovers is formed among the ICU team” – ICU doctor

“This is the basis that is currently missing” – ICU nurse

Concept 3

The team responded enthusiastically on concept 3 and 4, which was not expected beforehand. Reflecting provides the team to take on a helicopter view over the current handover process and to keep the quality of the handovers high over time. It was also indicated that reflection will take time and that it is important that moments for this are scheduled, of which a disadvantage is that it takes quite some time.

“I think it is very good to schedule reflection moments. It makes the threshold lower to talk about things that bother you” – ICU doctor

“It all starts with actually talking about it with each other” – ICU nurse

Concept 4

A vision wall gives people the feeling of being heard and can improve the communication between the doctors and nurses. Nonetheless, it differs per person when someone is open to these kinds of interventions or not. Also, reflection can cause endless discussions, which is not desired in an ICU environment where everyone is already short in time. Also, as indicated by all participants, a vision wall might easily result in a wailing wall.

“Making sure the nurses feel heard is actually a task we have to fulfil as doctors, but this is not always observed by us” – ICU doctor

“This might easily result in a wailing wall” – ICU nurse

6.4.3 Conclusion

All in all, by discussing the different concepts with the ICU doctors and nurses, various opportunities and obstacles were discovered. Beforehand, it was expected that the ICU team would value the more 'direct' solutions more, so concept 1 and 2. However, the discussions revealed a great preference for reflection as well, as this is something that they currently lack at their units.

The conversations revealed different core values, drivers for people to do the things they do. Looking back at the different discussions, the core values 'privacy', 'teamwork', 'attractiveness', and 'structure' came to the surface. For example, the PDMS extension was valued a lot especially for the nurses, as this effective way of communication at the same time guaranteed for privacy. Furthermore, teamwork turned out to be a very important driver, thereby managing expectations and improving communication. This mainly returned when discussing concept 3 and 4. Reflecting would increase their teamwork a lot. Also, attractiveness turned out to be a great driver for a potential concept for the ICU as all the concepts were valued for their attractive visual presentation style. This revealed their desire to have something looking attractive and inviting within this critical environment.

Besides, also some tensions between core values arose. The already known tension between structure and flexibility was derived, as already found during the fieldwork. In addition, a tension between development and stability was discovered. There is a desire for development and innovation within the ICU, however, simultaneously there is a strong need for stability as well. A challenge for the final concept will be balancing these conflicting values.

It can be concluded that the final concept should not focus on one specific proposal but should be a combination of some. Thereby referring back to the design goal and vision: offering a holistic solution to enhance the patient handovers at the ICU. Looking back at the insights obtained during the fieldwork, one can compose a concept covering the different ingredients. Therefore, it was decided create a combination of concept 1, 2, and 3. Concept 2 serves as a guideline which is the basis that is currently lacking, concept 1 is a way to make the currently used system supportive for the patient handovers, and concept 3, reflection, should be implemented to make sure the proposed structure of handovers will stay in line with the aims of the ICU team, also when the designer steps out of the context. Concept 4 will not be included (Figure 33).

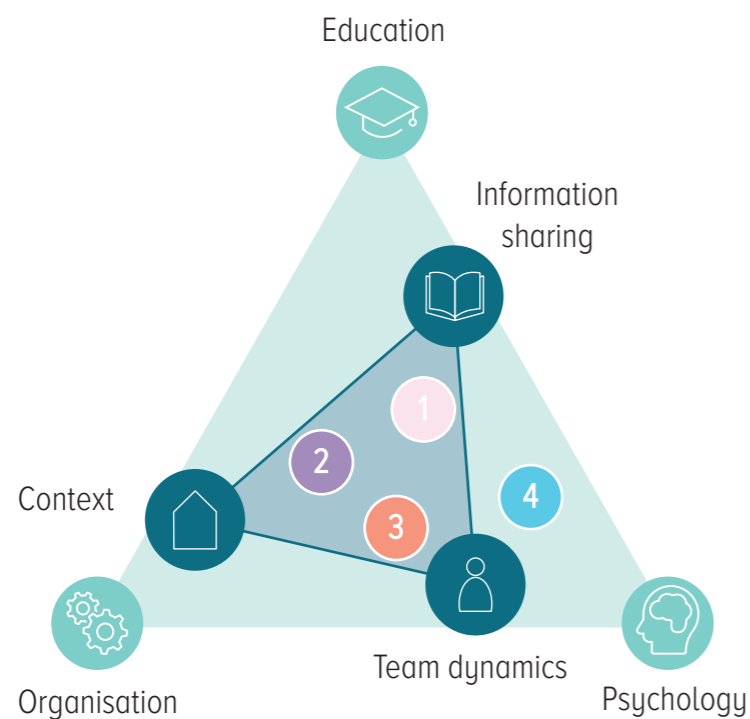


Figure 33: the relation between the insights from literature, ingredients obtained during fieldwork, and the concepts.

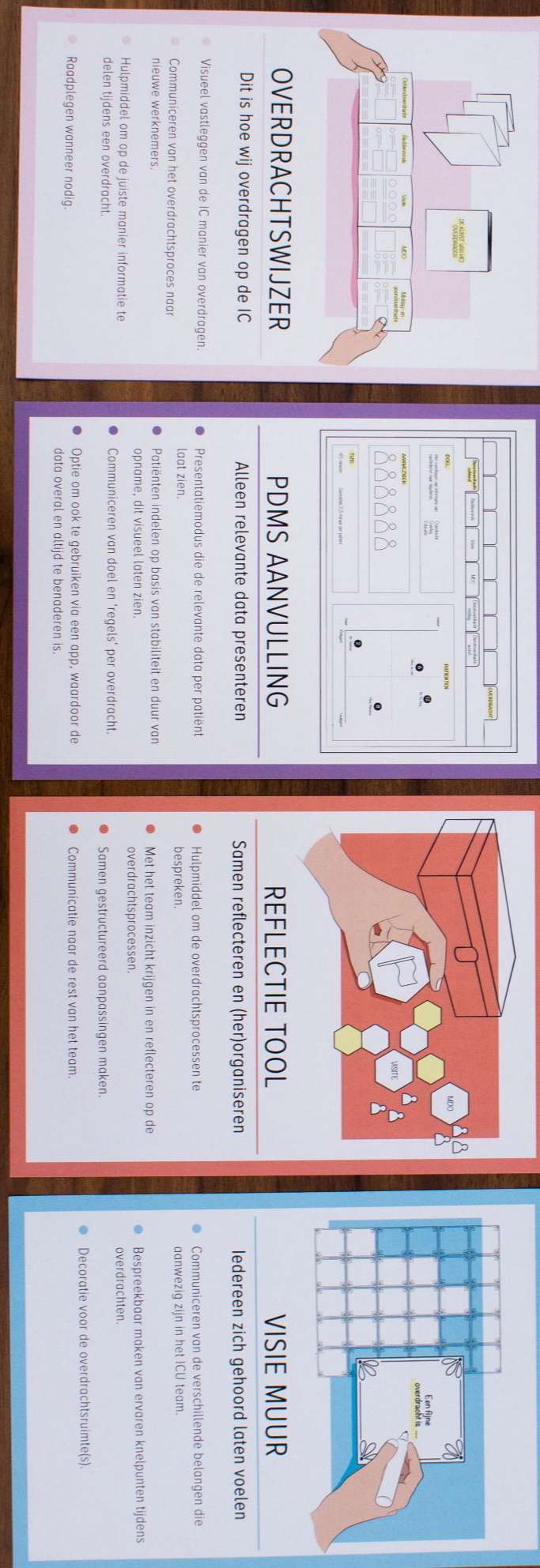


Figure 34: Impression of the evaluations with the concept cards.

6.5 SESSION WITH THE ICU TEAM

When there was decided on the final concept, a small session with the ICU team was organized to get input on this concept. A first low-fidelity paper prototype of the handover guideline was created and shared during the session to gain input on this part. The main questions to be answered for this study were:

- Which elements need to be included within the handover guideline?
- What is the general opinion of the ICU team regarding the final concept?

6.5.1 Approach

Before the session started, a small presentation about the design process was given to update the ICU team about the development of the project and to make clear how the final concept was generated. Moreover, the visuals presenting the results of the interviews were taken to the session as well, to give the team insight in the results of the field study in which some of them participated. When the design process and study findings were briefly presented, the session started, which included an exercise for the ICU team where they had to give input and correct the first rough proposal of the guideline. To enable them to do that, printed out versions were distributed among the doctors and nurses in which they had to make corrections with a green and red pen in pairs. Furthermore, they were asked to propose additional elements with a blue pen, and they had to mark the most important elements with small orange stickers. Some time for questions and discussion was scheduled as well. Only input on the guideline part of the concept was asked, because only 45 minutes were scheduled for the session as well as the presentation.

6.5.2 Results

In total, 17 ICU nurses and 14 ICU doctors attended and gave input on the presentation and participated in the session in which they worked on the content of the guideline part of the concept. Their input was very valuable, and their additional

comments were very useful for the final design as well. For example, it was discovered that actually one element was missing in the first proposal of the guideline, which is the moment in between the bedside round and medical round, where the responsible doctors and responsible nurse for a patient can elaborately discuss the patient with each other. Also, it became clear that the terminology used should carefully be chosen. For example, an ICU nurse can either be 'oldest shift', 'nurse', or 'student' and it is important to make these distinctions clear within the guideline. Besides input on the guideline, many suggestions for organizational change were also mentioned, for example merging the medical round and MDT, and moving some meetings from the handover rooms to the patients' rooms.

6.5.3 Conclusion

All in all, the session was a very valuable addition to the ideation phase of the project. Aside from that, presenting the results of the studies and potential directions for design were important aspects of the session, as it enabled the ICU team to understand what a designer can do for a hospital. Regarding the exercise that was given in the session, it turned out that the work I had done so far was a good first attempt to create a guideline. The main elements of the proposal to be adjusted turned out to be the parts presenting the stepwise structure for each handover. Also, the level of nuances in the terminology used could be improved. All their feedback was carefully reviewed and taken into account when creating the final guideline which was again a challenge, mediating between the different and sometimes contradicting input that was given. Besides input on the eventual tool, requests for a back order of the posters to hang in their handover room and a question from the children's ICU to also present my results to them, made me realize that the ICU team started to really see the value of what a designer can do for a hospital and especially an ICU.



Figure 35: Impression of the session with the ICU doctors and nurses.

7.0 | FINAL CONCEPT

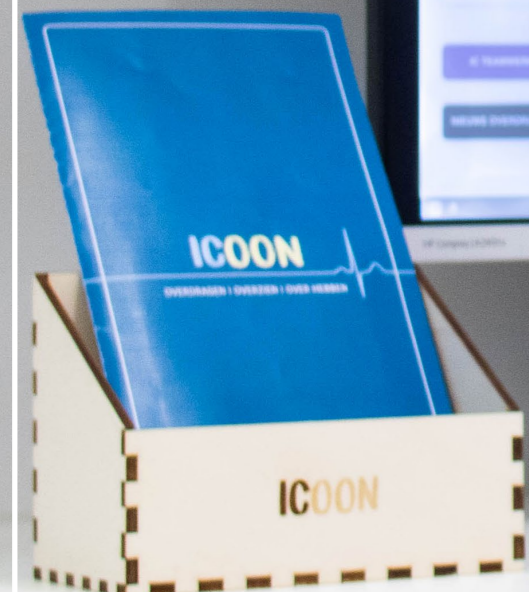
ICOON

OVERDRAGEN | OVERZIEN | OVER HEBBEN
COMMUNICATE | AUTOMATE | COLLABORATE

ICoon is a tool designed for enhanced patient handovers at the ICU. It aims to increase the experienced effectiveness and efficiency of the patient handovers by the ICU team by means of three components: *'overdragen'*, *'overzien'*, and *'over hebben'*, or *'communicate'*, *'automate'*, and *'collaborate'*.

Within this chapter, the visual as well as content considerations of ICoon are explained elaborately. Furthermore, a storyboard of use is presented, and this chapter is concluded with the necessary implications for the ICU organization.

- 7.1 ICoon
- 7.2 Storyboard of use
- 7.3 Implications for the organization



7.1 ICOON

About

Patient handovers belong to the daily practice of a critical care unit. However, the execution of these handovers is not always effective and efficient. ICoon supports ICU doctors and nurses to correctly and consistently hand over admitted patients to achieve a shared understanding of the patients' needs among the team. In addition, it allows to properly (re-)organize the handovers when necessary. The tool consists of three components: 'overdragen', 'overzien', and 'over hebben' (or 'communicate', 'automate', and 'collaborate'). In other words, ICoon offers a structured guideline, a supporting PDMS, and triggers reflection within the ICU team.

Overdragen - Overzien - Over hebben

'Overdragen', aims to align the expectations of the ICU team regarding each handover moment and entails that only relevant information is shared in an efficient way. Moreover, 'overzien' is a dashboard designed for the shift changes added to the current PDMS, allowing the ICU team to directly have a proper overview of the patient population at each unit. Besides, it facilitates that only relevant information is shown at the right time. 'Over hebben', will enable the ICU team to critically reflect together on their communication process and allows to make organizational changes when necessary. Thereby, initiating transformative learning (Mezirow, 1997).

Physical and digital

The complete concept is physically bundled into one folder (Figure 36). It was decided to make a physical version of 'overdragen' and 'over hebben', because it was observed that the ICU team does not always make extensive use of the online available resources. Moreover, the physical versions were designed and pressed with care, in such way that it does not feel as a piece of loose paper, but that it really feels valuable. Therefore, the physical tool will hypothetically be kept more carefully by the ICU team. The physical versions will always be available in the handover rooms, stored in the designated boxes. This might invite the ICU team to frequently make use of the artefacts provided.

Besides the physical editions only, the complete tool is also intended to be consulted on LUMC's digital protocol platform, iProva (LUMC, iProva, n.d.). As a matter of course, 'overzien' always has to be consulted from the LUMC computers via the MetaVision software.

A sheet containing all parts of the ICoon package can be found in Appendix I.



Figure 36: Cover of the final concept, ICoon.

OVERDRAGEN COMMUNICATE

Content

'Overdragen' explains the handover procedure at the ICU at the LUMC in detail. It serves as a tool for ICU doctors and nurses enabling them to handover their patients in a structured and desired way. Besides bringing structure to the handovers, this tool aims for aligned expectations among the ICU team regarding the handover moments. It supports that the information shared by the sender will be in line with the information expected by the receiver. The content of this tool is based on input given by the ICU team.

'Overdragen' differentiates between two handover moments of doctors, two for nurses, and two moments for both. All six different handover moments are explained according to the following structure: 'goal', 'focus', 'roles', and 'to mention per patient'. The latter is the most relevant part, as it guides the user through the verbal handover of each patient.

Appearance

The tool is shaped as a flyer folded into four different parts. Each handover moment is described on one part. It was decided to merge the guideline for the doctors and nurses, as one of the insights found during fieldwork was that there exists a gap between the doctors' and nurses' team. Therefore, it was a logical choice to merge both handover guidelines, symbolically bringing both groups together. To make sure that only relevant information is shown to the right person at the right moment, the tool can be folded in different ways (Figure 37). An explanation on how this tool could be used is presented on the back of the flyer.

The dimensions of 'overdragen' were chosen in such way that it would perfectly fit within the pocket of a doctors' or nurses' coat. This allows them to easily take the tool with them throughout their day when necessary.



- ▶ Description of the bedside round and medical round
- ▶ Relevant for doctors as well as nurses



- ▶ Description of the central shift change and the shift change next to bed
- ▶ Relevant for nurses



- ▶ Description of the shift change and MDT
- ▶ Relevant for doctors

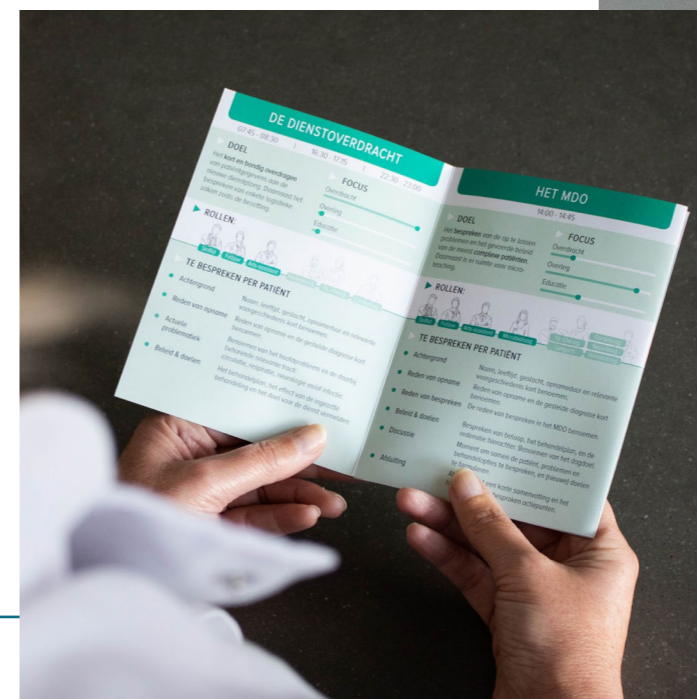
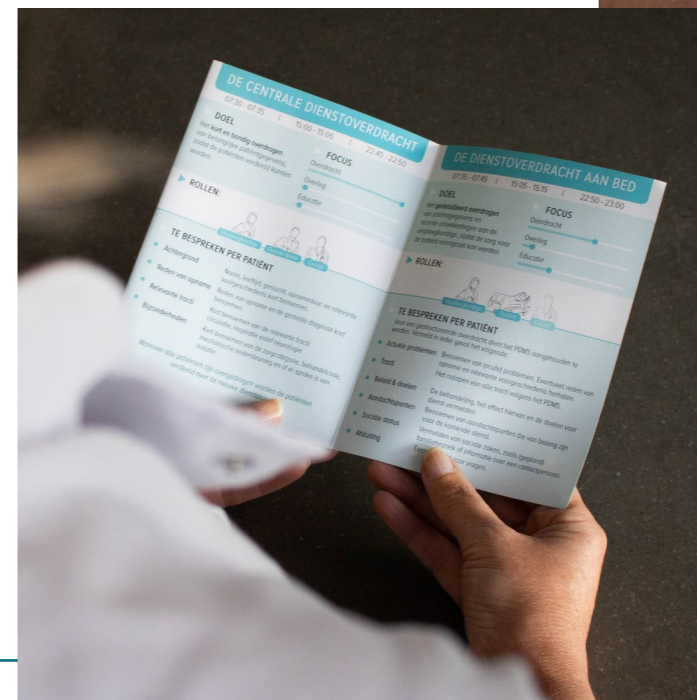
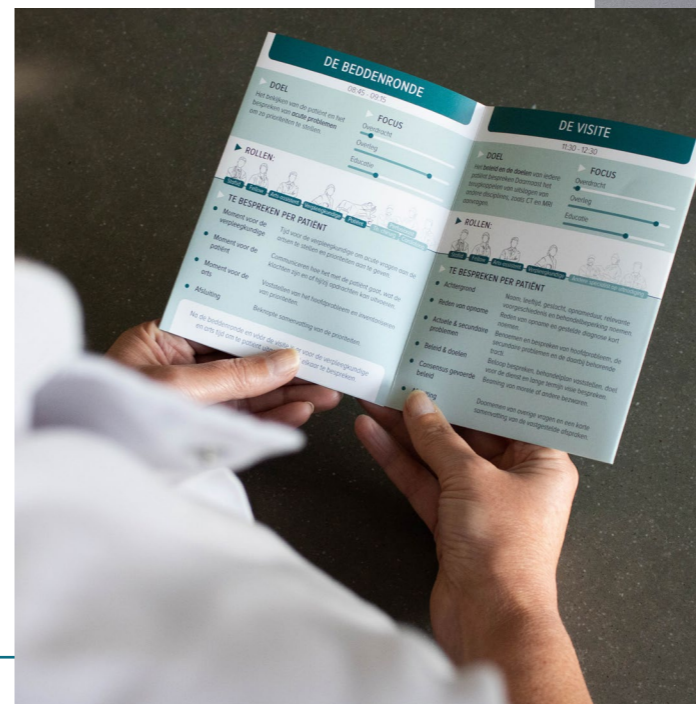


Figure 37: Overdragen

OVERZIEN

AUTOMATE

Content

The dashboard 'overzien' is especially designed to support the shift changes at the ICU. Other meetings such as the medical round and MDT demand extensive patient information which is already available within the current PDMS. 'Overzien' aims to improve the efficiency of the handovers, because only relevant patient information appears on the screen. Besides, presenting the right patient at the right moment will contribute to the effectiveness as well. The information presented on the dashboard is based on the content of 'overdragen', which was created in collaboration with the ICU team.

Both doctors and nurses have a slightly different interface, as their shift changes are intradisciplinary and both groups have slightly different priorities for shift changes (for doctors, this is mostly being updated about each patient, for nurses, this is to divide the patients among the nursing team).

An adapted version of the quadrant found during the data analysis of the interviews (see chapter 4.2.3) formed the basis for the dashboard. In both the doctor's and nurse's interface, the patients on the unit are plotted on a quadrant based on instability, admission time, and patient category. Thereby, a direct impression of the patient population is given allowing the ICU team to immediately make an estimation on how their day is going to look like. More information about the different patient categories can be found in Appendix J.

Within the doctors' interface, first, a trend line is presented, in this case showing blood pressure and heartbeat of the selected patient. The idea is that the responsible doctor can select the trend that is relevant to show per patient. Furthermore, a brief overview of the reason of admission, acute problems based on the relevant tracts (circulation, urology, respiration, neurology, infection), and the treatment goals are presented. Additionally, there exists the possibility to directly consult patient scans when necessary. This will significantly improve the meeting's efficiency, as currently an external program needs to be consulted which takes quite some time to start up (Figure 38).

- ▶ Checklist of practicalities at the end of the morning shift change.

- ▶ Possibility to consult the floor plan of both units.

- ▶ Quadrant presenting patients based on instability, admission time, and patient category.

- ▶ Possibility to present trend lines.

- ▶ Presentation of most important patient information.

- ▶ Editing and inserting patient information with minimal effort.

- ▶ Possibility to directly consult scans.

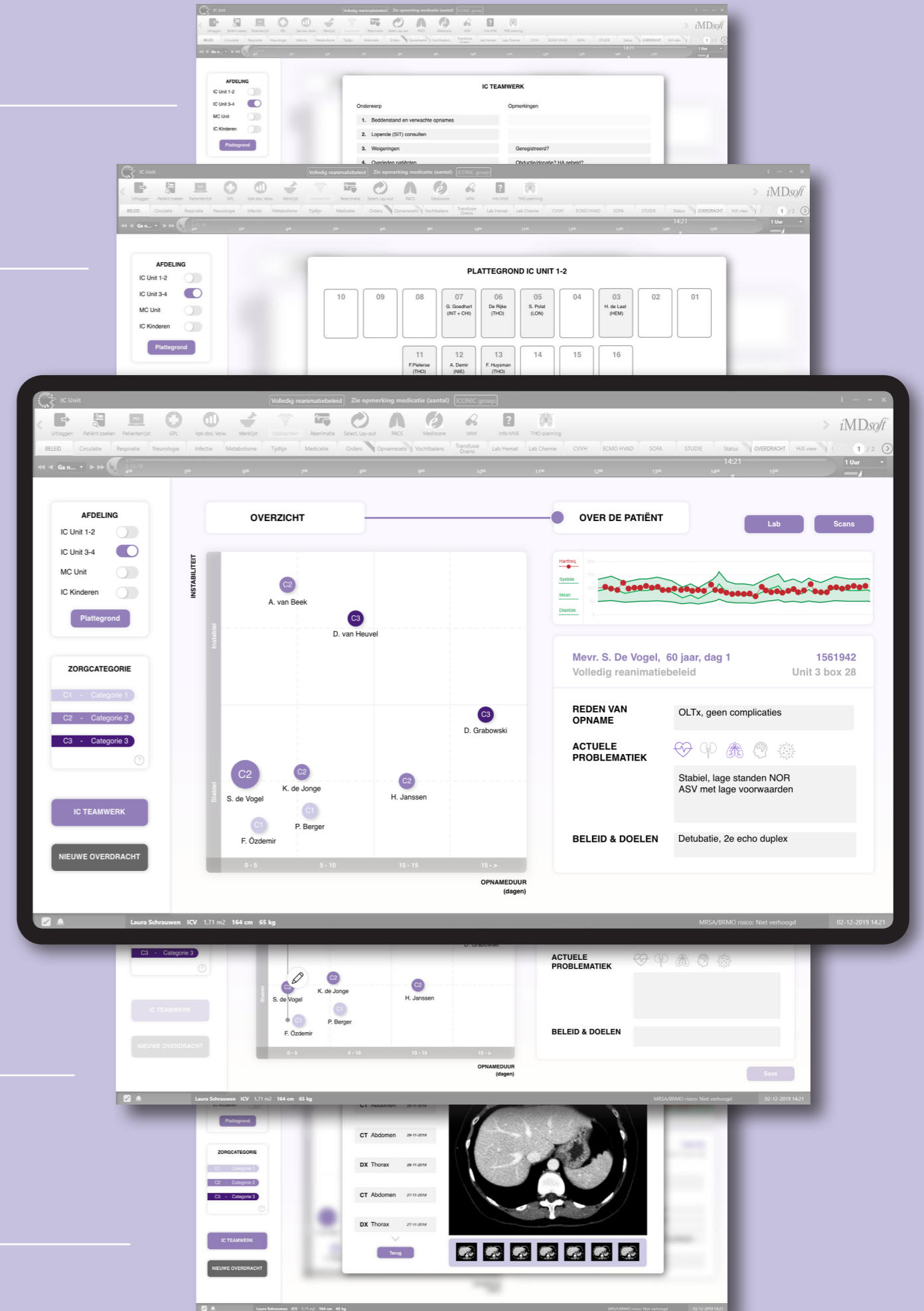


Figure 38: Overzien - doctors

The nurses' interface does not include a trendline, as this is not a relevant part of their very brief shift change. In their case, a brief overview of the patient's background is shown, followed by relevant tracts, points of attention and concluded by goals for the coming shift (Figure 39).

In both cases, a human hand is necessary to create a reliable overview within the quadrant. Therefore, the responsible doctor or nurse can click on the button 'new handover', on which the system will react with automatically creating the quadrant overview including patient information of each admitted patient. However, the location of the instability on the y-axis needs to be refined by human input, as according to the consulted doctors and nurses, this cannot be decided by a system (yet). Furthermore, the patient information generated by the system can be manually adjusted as well (Figure 39).

▶ **Link to the doctors' dashboard:**
<https://xd.adobe.com/view/fc77000d-e454-480f-5f84-ac22f9b83440-8a46/?fullscreen&hints=off>

▶ **Link to the nurses' dashboard:**
<https://xd.adobe.com/view/2d53a9c6-31fc-4a7d-5e2b-e76a91410527-5b62/?fullscreen&hints=off>

▶ Possibility to consult the (already existing) handover form.

▶ Possibility to consult the floor plan of both units.

▶ Quadrant presenting patients based on instability, admission time, and patient category.

▶ Presentation of most important patient information.

▶ Editing and inserting patient information with minimal effort.

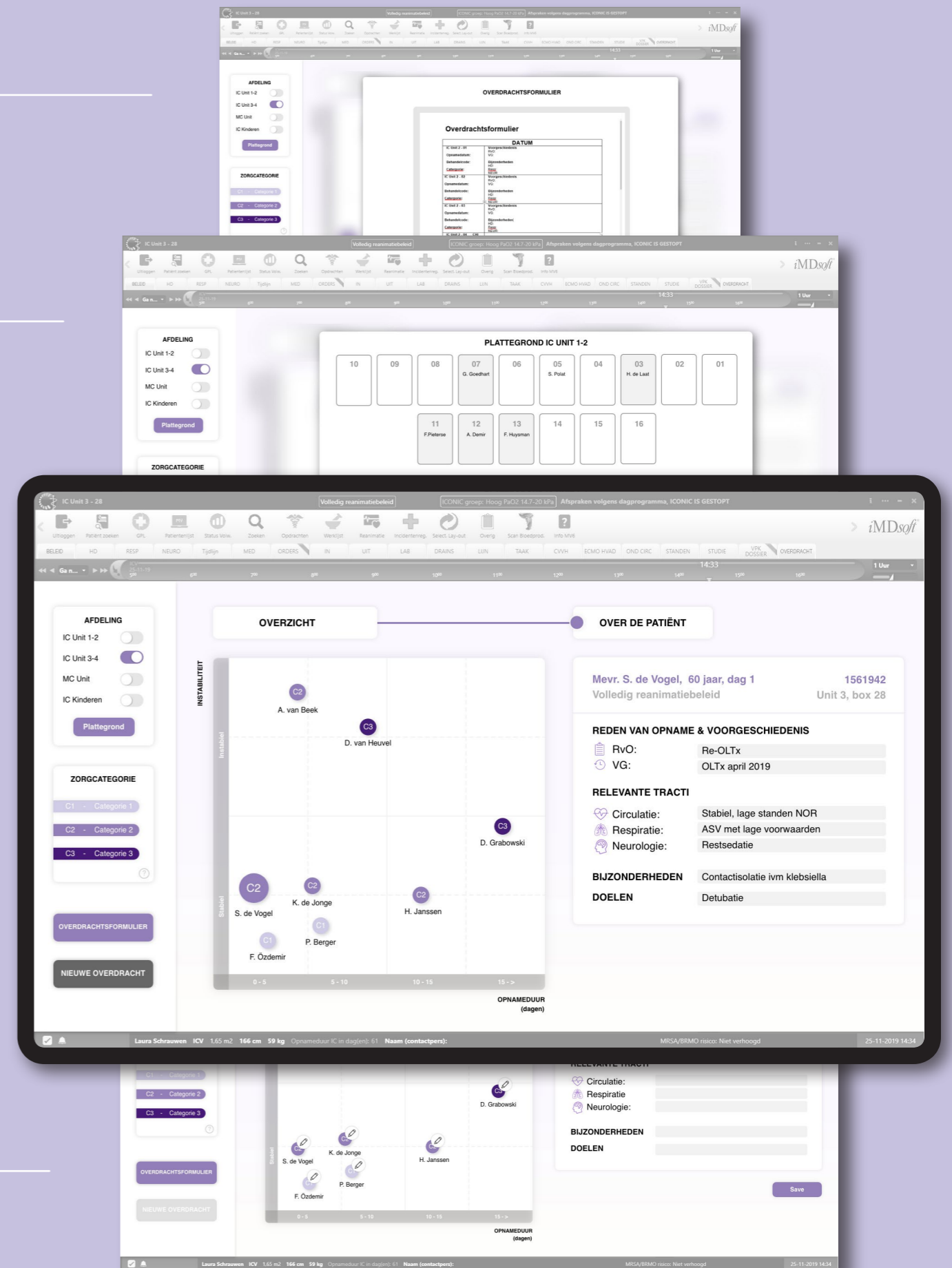


Figure 39: Overzien - nurses

Appearance

The most important element of the dashboard, the quadrant, is always visible to create an overview and to allow the ICU team to easily switch between patients.

Sliders serve as unit selection buttons, because this interaction allows to open more units simultaneously, making it possible to compare patient populations from different units. Moreover, these sliders are known interactions which makes the interface intuitive in use.

Interactive media, such as this dashboard, can make use of Gestalt laws of perception to organize visual information and to structure user experiences (Graham, 2008). Therefore, the Gestalt Theory was taken into account while creating the layout and position of all the elements within the interface. Gestalt refers to a structure, configuration, or layout that is unified and has specific properties that are greater than the simple sum of its individual parts. Using this theory prevents unexpected interpretations by the reader (Graham, 2008). The colour purple was chosen, as it appears calm and pleasant to look at, and it also allows for clear contrast distinction. This colour clearly distinguishes the background from the objects on the foreground and allowed to order the different patient categories by the shade of the same colour. Additionally to the patient category distinction by colour, the category numbers are presented as well (C1, C2, C3) to not exclude users who for example suffer from colour blindness. Furthermore, it was decided to locate elements belonging

together close to each other, as items that are spatially located near each other seem part of a group, while items that are apart are perceived as separate. The boxes visible in the background strengthen this principle within the dashboard.

Lastly, the Gestalt law of continuation was applied, as the reading direction of the dashboard is from left to right, because people intuitively read from left to right. Moreover, this principle is reinforced by the line appearing on the top pointing from the quadrant to the patient information, guiding the user to look at the right when selecting a patient.

Moreover, the medical interface design guidelines proposed by Zahabi, Kaber, & Swangnetr (2015) were taken into account when designing the dashboard. First, icons of the tracts were used within each patient overview to promote the readability, instead of presenting text only. Second, the amount of information presented was reduced to only the necessary content for the dedicated handovers, to make the handovers more efficient on the one hand, and to reduce cognitive load of viewers on the other hand. Third, the terminology used in both the doctors' and nurses' interface was aligned, to avoid misinterpretations between both groups. Lastly, a natural workflow was created, by making the design and sequence of the dashboard screens correspond to the current flow of the patient handovers.



Figure 40: Dashboard used in the context.

OVER HEBBEN

COLLABORATE

Content

It is important to tailor healthcare delivery to the needs of ICU teams (Al-Abri, 2007). Moreover, measuring and evaluating the value of a (new) service and the impact on the organization is a crucial issue to consider in order to realize change within an organization (Foglieni, Villari, & Sleswijk Visser, 2018). Therefore, the component 'over hebben' was created. 'Over hebben' triggers reflection within the ICU, which can for example be initiated during scheduled reflection moments. It facilitates reflection on three levels: personal, interpersonal, and contextual, and simultaneously includes a pathway for change: reflection, planning, and action. The content of this tool is based on literature found on reflection in healthcare.

It was found that a strategy to improve clinical practice is to involve reflection in groups of medical professionals. When everyone regularly reflects on the handover processes and tries to introduce opportunities and improvements, this will ensure improvement power. Thereby, transformative learning is initiated, as every one of the ICU team will be triggered to critically reflect and take actions on one's reflective insights (Mezirow, 1997).

It was desired to make this part of the concept in such way, that it included reflection on a personal and organizational level, and that it invited to take actions for improvement.

Smith (2011) proposes different perspectives to trigger thoughts about that one is doing and what it affects. The proposed perspectives in which one can reflect (personal, interpersonal, and contextual) were used within this tool. Besides these perspectives, Broekhuis & Veldkamp (2007) proposed a reflexivity method which encourages dialogue and reflections between healthcare professionals and

enables change. This iterative process consists of three steps: reflection, planning, and action. These three steps were integrated in the tool as well, to make sure that organizational change is triggered to continue improving the ICU organization.

Each reflection part contains trigger questions to support the ICU team in reflecting on these different levels. The use of the tool and questions one wants to answer in which order can freely be decided by the user and depends amongst others on the reflection subject. Important to mention is that the reflection process will only be effective when the ICU team participates actively, and times and places for learning and reflection are set aside. This will be further explained in chapter 7.3.

Appearance

This tool also takes shape of a flyer which is folded in four different parts. Each perspective, personal ('*persoonlijk*'), interpersonal ('*interactie met anderen*'), and contextual ('*organisatie*'), is represented on a separate part from left to right. From top to bottom, the pathway for change is constructed: reflection, planning, and action ('*huidige situatie*', '*uitdagingen & ideeën*', & '*vervolgstappen*'). The different perspectives and pathway of change are visualized with small drawings and icons. On the back, there is space for the user to write or draw ideas and notes. Besides, an explanation on how this tool could be used is presented on the back.

The dimensions of 'over hebben' were chosen in such way that it would perfectly fit within the pocket of a doctors' or nurses' coat. This allows them to easily take the tool with them throughout their day when necessary.



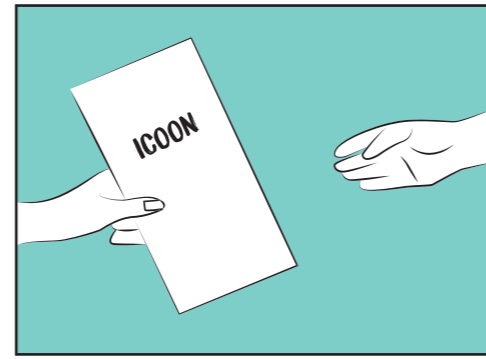
Figure 41: Over hebben

7.2 SCENARIO OF USE

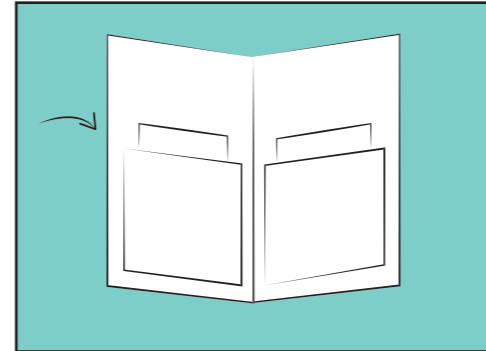
The scenario visualised on the right presents the scenario of use for both doctors and nurses. The different images explain how each different component of ICoon, 'overdragen', 'overzien', and 'over hebben', is imagined to be used in the ICU context.

Below the scenario, two timelines showing all the handover moments for doctors as well as nurses are shown. The coloured dots communicate which component of ICoon can be used during which handover moment or meeting (Figure 42).

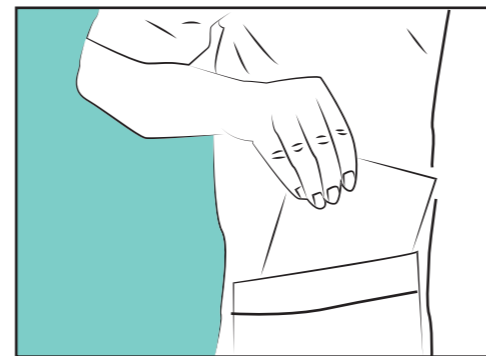
- Overdragen
- Overzien
- Over hebben



1. The ICoon package is given to the ICU doctors and nurses, for example by the team leaders.



2. The left pocket contains the 'overdragen' flyer, which can be used as a guideline for each handover moment.



3. The flyer can be taken out and fits perfectly in a coat's pocket, so that the guideline can easily be taken.



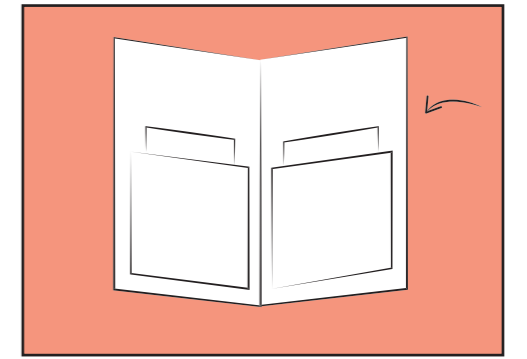
1. Prior before each shift change, minimal preparation is necessary. This is done by the responsible doctor or nurse.



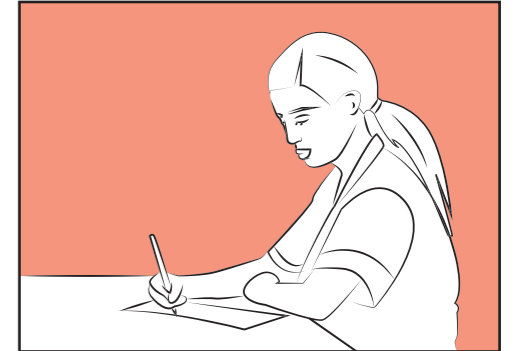
2. During the handover, the PDMS is opened and the patient overview is presented. The most important patient information is shown.



3. The proper overview that is offered contributes to co-creating the right picture of each patient.



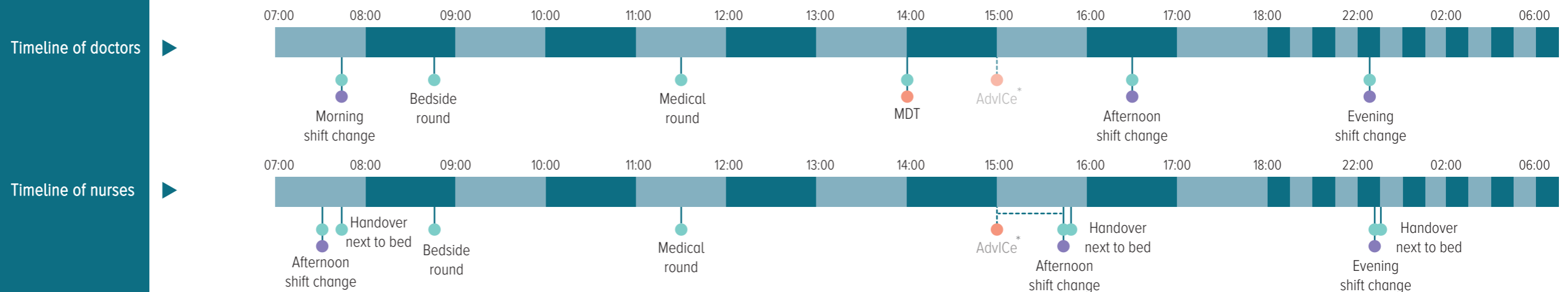
1. The right pocket contains the 'overdragen' flyer, a tool supporting reflection within the ICU team.



2. The tool offers space for individual as well as group reflection.



3. One in a while a reflection meeting for the ICU team is organized. This is supported by 'over hebben', as trigger questions are presented.



*Advice is a common education moment.

7.3 IMPLICATIONS FOR THE ORGANIZATION

Transformation design

Making ICoon work at the ICU involves some changes and therefore implications for the organization. Effective change can be characterized as unfreezing old behaviours, introducing new ones, and re-freezing them (Al-Abri, 2007). In order to design a means of continually responding, adapting and innovating within the ICU, the component 'over hebben' was added to ICoon. 'Over hebben' aims for ongoing change, which can be labelled as transformation design. Transformation design seeks to not only leave the shape of a new solution behind, but the tools, skills, and organizational capacity for ongoing change among the ICU team instead (Sangiorgi, 2012). Transformative change involves a process of transformative learning: effecting change in the ICU team's frame of reference (Mezirow, 1997). This will take place through regular critical reflection moments among the ICU team. In other words, when I will leave the unit, I need to leave the right tools behind, so that the ICU team can continue with my work and realize change by themselves.

Ownership

When aiming for continuation and compliance (Gurses, et al., 2008), someone or several members of the ICU team need to have ownership over ICoon. The responsible person(s) need(s) to make sure that the team works according to the proposed tools and needs to act when (organizational) changes are necessary. This role can for example be fulfilled by nursing team, or by one of the staff members.

Implications per component

Each component of ICoon involves some specific implications for the organization:

First, regarding 'overdragen', it is important that everyone in the current team receives an ICoon package, so that everyone is informed about the proposed handover structure. Furthermore, when new people are going to work at the ICU, they need to directly receive a package so that they can work according to this structure as well. In case of adjusting this component, any knowledge of InDesign is not necessary as the aim is that the PDF will be adjustable via Adobe Acrobat, a program that is also available at LUMC and is very easy in use.

Second, 'overzien' needs to be implemented in the current PDMS as a new tab to make it work during their handovers. To realize this, the PDMS expert working at the ICU can be consulted and can be made responsible for this. Furthermore, the ICU doctors and nurses need a small introduction to the new interface.

Third, 'over hebben' is the most important component regarding transformative change. It requires that reflection moments are scheduled with the complete ICU team. As mentioned before, this can for example be directed by the nursing team leaders, or a staff member can be made responsible for this. This responsible person has to make sure that these reflection moments are communicated to the team, prepared, and carried out on suitable moments (for example monthly during their common Tuesday education moment). After reflection, it is important that the responsible people actively act upon the results of a reflection session, which can for example involve organizational change. This is necessary to move forward with success.

The moment that the content of 'overdragen' is seamlessly integrated into the handovers, there is no need to frequently consult this guideline anymore. However, when new employees are hired, which frequently happens within the ICU, the complete ICoon package should always be provided to them. The same applies to the reflection tool, 'over hebben'. When reflection is integrated within their workflow, this tool can move more to the background. Important is that both components can always be consulted when necessary.

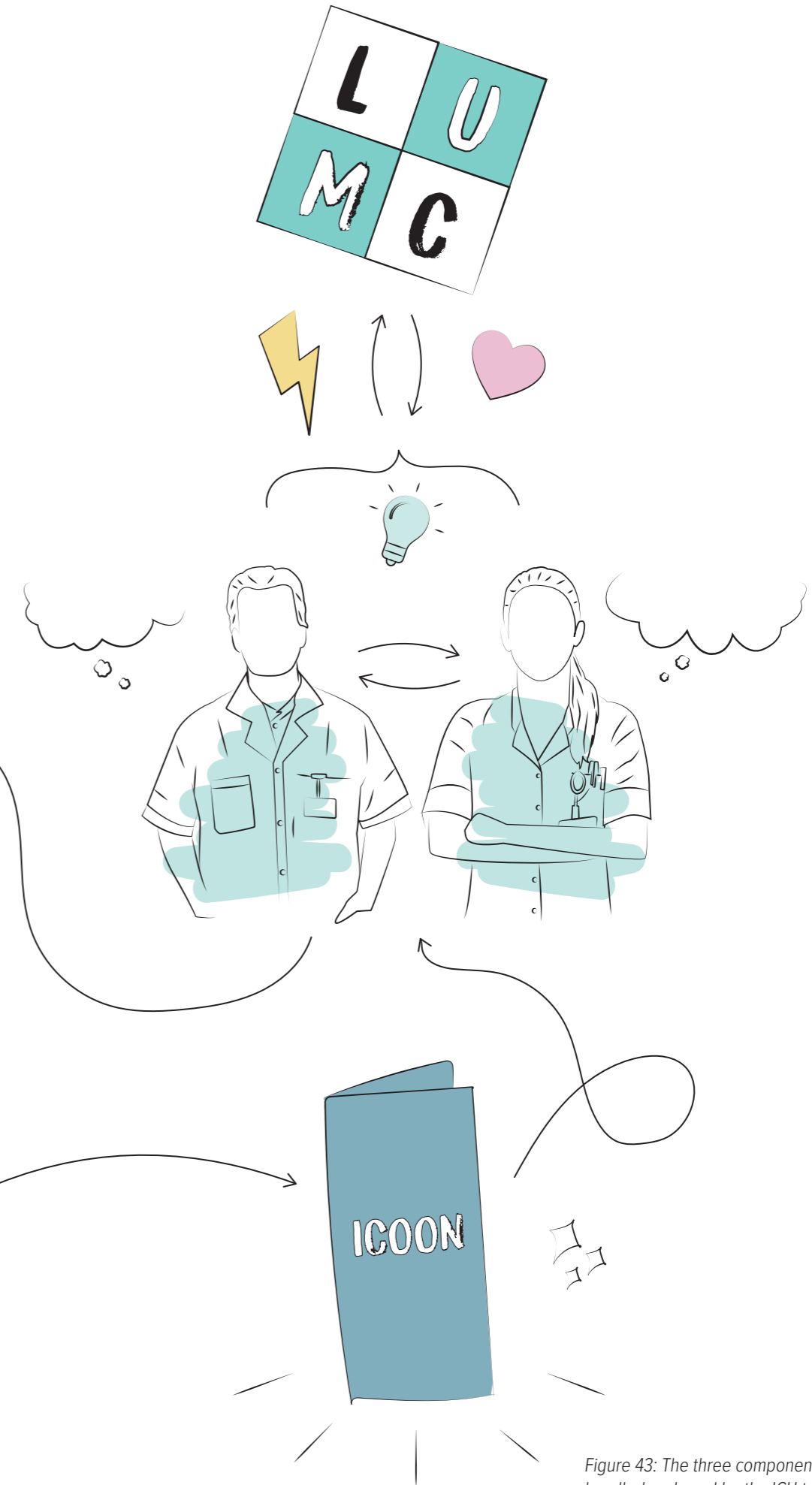
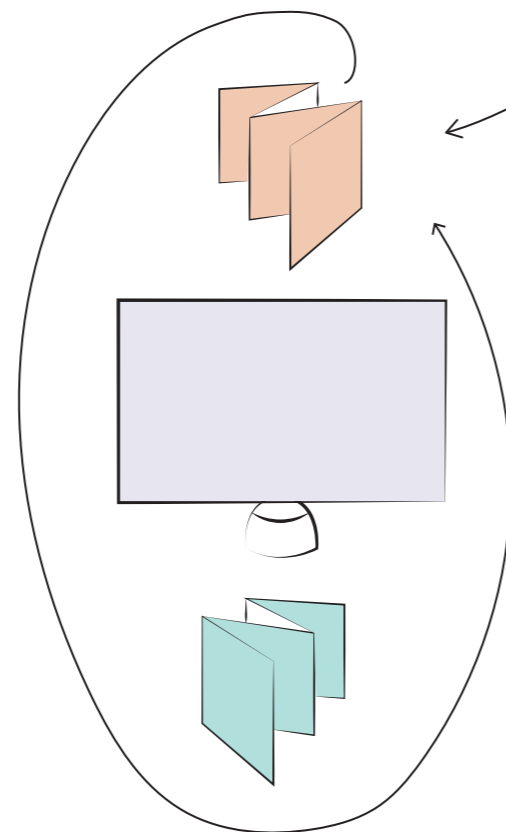


Figure 43: The three components of ICoon are bundled and used by the ICU team. They can initiate (organizational) changes and which can be translated back to the different components.

8.0 | EVALUATION

The last step of this design process was to elaborately evaluate ICoon with the ICU team. The aim of the evaluations was twofold: Figuring out the added value of ICoon within the ICU regarding the experienced effectiveness and efficiency and assessing the support 'overzien' facilitates during patient handovers. Therefore, the evaluation consisted of two parts: evaluation by conversation and evaluation in practice. The evaluations were done with both ICU doctors and nurses.

In this chapter, the evaluation set-ups are explained, the obtained results are presented, and future recommendations regarding the concept based on the outcomes of the tests are given. Finally, some limitations are pointed out.

8.1 Evaluation by conversation

8.2 Evaluation during shift changes

8.3 Future recommendations

8.4 Limitations of this project



Figure 44: Impression of the evaluations by conversation.

8.1 EVALUATION BY CONVERSATION

All three components of ICoon ('overdragen', 'overzien', and 'over hebben') were evaluated by conversation with different members of the ICU team at the LUMC. The main question to be answered was:

Does ICoon provide added value regarding the experienced effectiveness and efficiency of the ICU team regarding their patient handovers?

8.1.1 Approach

Different members of the ICU team including doctors and nurses were asked to evaluate the three different components of ICoon. These evaluations were shaped as conversations in which all participants were able to express their opinion regarding the concept ICoon. During each evaluation, first the final design of ICoon was shown and explained to each participant, who then had some time to carefully go through the concept. This was supported by presenting a scenario of ICoon to make the participants understand how and when the different components could be used within the ICU context (Appendix K).

Second, a semi-structured interview with each participant was held. The questions concerned first impressions, advantages and disadvantages of each component, and

forming a future vision regarding the implementation of ICoon. When all questions were answered, an evaluation form was given to the participants in which they could indicate their thoughts and feelings on different provided scales. Important was that each participant thought out loud while doing the activity, so that it became clear why certain decisions were made.

A complete setup of the evaluation can be found in Appendix L. The evaluation form that was designed and used can be found in Appendix M.

8.1.2 Results

ICoon was evaluated with 6 doctors and 6 nurses respectively, including the head of the department, the PDMS expert, and the nursing team leaders. The conversations lasted between 15-30 minutes, depending on the time each participant was available. On the following pages, a summary of the comments given by doctors and nurses is given per component of ICoon.

"IT MAKES THE PATIENT HANDOVERS MORE EFFECTIVE IN THE SENSE THAT PEOPLE ARE NOW BETTER ABLE TO DISTINGUISH MAIN ISSUES FROM SIDE ISSUES."

- Nurse

OVERDRAGEN

► Expectations are aligned

Both the doctors and nurses appreciated that the handover guidelines for both groups were inserted in one document. According to them, this would align their handover processes, their terminology used, and it would symbolically bring both teams more together.

Both the doctors and the nurses believed that this tool would improve their teamwork, especially during their joint handover moments, as expectations will be more aligned.

"I think the doctors and nurses will understand each other better" – Doctor

► Finally, there is an overview

According to the involved nurses, the main added value of 'overdragen' is the fact that this tool offers a basis on which you can always reflect. It offers the opportunity to reflect on past practices and simultaneously allows to form a future perspective on how the handovers should be done. This would not be possible without a common agreement, which is offered by 'overdragen'. The doctors, especially the ones who just started working at the LUMC, indicated that they wished they received such guideline when they started: it would directly clarify how the handovers are organized. Both the doctors and nurses explicitly mentioned that it is good that there finally exists an overview of the focus of each handover, and that it is actually very weird that this was not there yet.

"I just started here and wish I had something like this to carry with me, especially during the first days."
– Doctor

► The graphic design is supportive

The doctors as well as the nurses really valued the graphic design of 'overdragen' and indicated that the graphic design is something they are really sensitive to. Especially because every other document or interface they are currently using is not carefully designed by someone.

They were convinced that this attractive layout will result in more people willing to use it. It increases the extent to which the tool is inviting to use and can prevent that this tool will completely move to the background. However, this is something that needs to be proved over time.

"I would love to put ICoon on my desk, how nice that you can put the necessary parts in your pocket!"
- Doctor

► The right focus

A by doctors repeatedly mentioned added value was that the main problem and goals for the shift are explicitly stated as an essential part of a handover in this tool. Mentioning the main problem and goals for the shift are both essential elements in a handover, but are not always touched upon right now. The same applies to nurses, of which the goal per patient was something they did not even always discuss during their usual central handovers. This overview provides them with the right focus.

"It makes the patient handovers more effective in the sense that people are now better able to distinguish main issues from side issues." – Nurse

OVERZIEN

► Overview of patient population at a glance

Visually presenting the patients in the quadrant made both the doctors and nurses very enthusiastic. The doctors commented that it tells them so much more compared to the floor plan they are currently using, as it shows the patient population at a glance, which is interesting to consider when handing over quite a lot of patients in a relatively short amount of time. Furthermore, they commented that the overview would be useful when deciding which patients you want to discuss and how elaborate you want to discuss them. The nurses mentioned that the overview might support proper division of the nurses among the patients. Both the doctors and the nurses were questioning whether the overview presented would bring more structure to the handover, as this still strongly depends on the person who is handing over.

“This will be super useful when we are dividing the patients among the team, especially for the students” - Nurse

► Implementation in current PDMS

It was valued by both the doctors and the nurses that the current PDMS, MetaVision, would be the system in which the dashboard would be implemented. People do not have to get used to a new system and far less money is needed to be invested. It was commented by both the doctors and nurses that ideally, the system could be linked to the dashboard and links the right information automatically, in order to prevent that using this dashboard needs too much time investment prior to a handover.

“The fact that it is implemented in the current PDMS makes it easier to realize something like this” - Doctor

► Order of handing over

Some points of attention mentioned by the nurses were the fact that for the older nurses this new dashboard might be a very big change in their workflow. Also, since they are currently used to hand the patients over according to their room number, they will have to get used to this as the dashboard requires them to reconsider the structure in terms of patient order in which they will be handing over. The doctors did not see the order as an issue, but as an opportunity to properly choose the order and elaborateness of handing over their patients.

“Reconsidering the order in which we are handing over patients might be a big change in the workflow for some of us” - Nurse

► Reconsidering ambiguities

Some doctors were not familiar with the patient categories presented on the dashboard, which is something to consider

in the future. All nurses were familiar with these categories, but during the evaluations it was noticed that the boundaries of each category are not completely clear. Furthermore, among the doctors there arose some questions around the term ‘instability’. They wondered whether this is an objective value calculated by the system, or that it should rather be a subjective representation indicated by the responsible doctor. Defining or changing this term used is probably something that needs to be done throughout using the system and assessing what works and what does not work.

“I am not that familiar with the patient categories, it is something that nurses mainly use” - Doctor

► Graphic design is supportive

The graphic design of the dashboard was valued a lot by both the doctors and the nurses. It supports using the PDMS in a presentation mode which is not something they can do with their current system. Furthermore, they indicated that the arrangement of elements and colours used made it pleasant and attractive to look at the screen.

“You use the human senses effectively to facilitate absorption of the necessary patient information” - Doctor

► Potential according to PDMS expert

The expert responded very enthusiastically when the dashboard was presented. Directly, he started to brainstorm about the possibilities relating to this proposal regarding the current PDMS. He mentioned that the overview of the patient population in the quadrant is definitely of added value, as would support the handovers. Furthermore, he really appreciated the visual presentation. He thought that the axis presenting the admission time also has an added logistics function, as both units need to have a balance between short and long admitted patients, which has to be taken into account when admitting new patients.

Points for attention were that it is probably not possible to link the patient’s scans directly to the dashboard, as these pictures are provided by external software. Furthermore, he suggested that perhaps it would be useful to add the specialism abbreviation to each patient in the quadrant. This might make it easier to search for and remember specific patients.

The PDMS thought that implementing this dashboard within their PDMS would be possible, but external ICT support would be needed to realize it.

“I think this is certainly useful when it can be developed. It already makes me enthusiastic to see what I can do with this within the current functionalities of MetaVision” - PDMS expert

OVER HEBBEN

► A first step

It was mentioned by both the doctors and nurses that currently, when they have an evaluation or reflection meeting, these meetings are always about medical procedures, but never about their teamwork and organization, although there exists a need for that. “Over hebben” may be the first step to realize this. In contrast to ‘overdragen’ and ‘overzien’ which can be used directly, ‘over hebben’ requires more organizational preparation to realize reflection within the team. Only presenting this tool will not be enough to embed reflection within the team.

“This is an important component to have as well, when you currently want to change something you do not know where to actually start” - Doctor

► Lowering threshold

This tool and the reflection it involves was especially valued by the nursing team leaders and the head of the department, who find it very important that these moments will take place. They already suggested some moments in which this tool might be suitable to use. It was mentioned several times that this tool might make it easier to talk about issues you are facing, instead of keeping them for yourself.

“This lowers the threshold to start a discussion and change things, which is very important” - Doctor

► Willingness to use strongly depends on person

One of the doctors mentioned that reflection always makes you grow as a person. When this is effectively implemented within the ICU, the job satisfaction of the ICU team might increase, as frustrations will be heard and might be eliminated. However, it was frequently commented that it really depends on the person whether someone is willing to use this tool or not.

“It really depends... not everyone is willing to use something like this” – Nurse

► Future use is questionable

As already mentioned, it is important that there need to be scheduled moments in which ‘over hebben’ will be used, as people are probably not going to initiate usage by themselves. The nursing team leaders already had some potential meetings in mind wherein this tool might be useful. Moreover, they were wondering how usage would turn out in practice: would the team be willing to do preparation? Which questions are most relevant to address? What effect would it have on realizing change?

“I think our work meetings might be interesting moments to use this tool for” - Nurse

8.1.3 Conclusion

Conclusively, each component of ICoon provides a different main added value to the ICU team. Compared to the current situation ‘Overdragen’ provides focus, structure, and aligns expectations which overcomes the issue of people feeling irritated or misunderstood during handovers. Furthermore, ‘overzien’ brings overview, which stimulates the doctors and nurses to handover more efficiently and directly provides an understanding of the patient population. Finally, the participants in the evaluation felt that ‘over hebben’ can have a positive impact on the teamwork within and between the team of nurses and team of doctors.

“YOU USE THE HUMAN SENSES EFFECTIVELY TO FACILITATE ABSORPTION OF THE NECESSARY PATIENT INFORMATION”

- Doctor

“THIS LOWERS THE THRESHOLD TO START A DISCUSSION AND CHANGE THINGS, WHICH IS VERY IMPORTANT”

- Doctor



Figure 45: Impression of the evaluations in practice.

8.2 EVALUATION IN PRACTICE

Besides evaluating ICoon by conversations, ICoon was also tested during the real patient handovers of doctors and nurses at the ICU. The main element tested was the dashboard ‘overzien’. The main question to be answered was:

How does the dashboard ‘overzien’ support the patient handovers of the doctors and nurses working at the ICU?

8.2.1 Approach

ICoon was evaluated during three different patient handovers: The MDT of the doctors, the afternoon shift change of the doctors, and the nurses’ central shift change in the afternoon. As the dashboard designed was still a prototype and not implemented (yet) in their PDMS, some preparation was needed to put the right patient data into the dashboard. Therefore, the patient data was inserted in the

system together with the responsible doctor or nurse prior to the concerning handover. After the preparation, all three handovers were carried out supported by the ‘overzien’ dashboard. As mentioned earlier, the doctors’ dashboard was tested during two different handovers, the MDT and the afternoon shift change. The reason for that was that this allowed to test the effect when the team knew how to use and read the interface, thereby taking into account the learning curve that is necessary to understand a new interface. Unfortunately, this was not possible to do with the nurses as well, as their team is completely different during every shift. To evaluate in which ways the dashboard was supportive during the handovers, observations were done and the people attending the handovers were asked to share their reactions afterwards.

A complete setup of the evaluation can be found in Appendix N.

8.2.2 Results

Evaluation with doctors

► Visual representation helps interpretation

Both handovers were prepared with the responsible fellow during the day shift. The first responses were positive. The layout was valued a lot, and the icons and visual representation of the patients and the data made the dashboard easily to understand and interpret. Also, already during this preparation, some elements that need to be reconsidered became clear: a small text box for the patient’s history should be added and the box intended for the goals has to be a bit bigger. It was also suggested to make the quadrant become smaller when a patient is selected, in order to create more space for the patient data.

“I really like the appearance of the dashboard including the supportive icons” - Doctor

► Making the goal for the shift explicit

All doctors were enthusiastic about the fact that the goal for each patient was explicitly presented. It is crucial to mention this during a handover, as the goal is an essential element where everyone has to be updated about, in order to move forward with each patient. However, this is something that is sometimes forgotten and currently not explicitly presented within the PDMS.

“It is good that the goal for the day is explicitly presented” - Doctor

► Enough information for shift changes but not for more elaborate meetings

While testing the dashboard during the MDT, it became clear that access to more patient information is necessary to elaborately discuss important patient details. Although the current dashboard was actually only designed for the shift changes, the doctors mentioned that when the dashboard would be implemented in the actual PDMS, it is still possible to switch to other tabs within the system. The dashboard will merely serve as an overview and introduction to each patient during these discussion meetings.

“During an MDT or medical round more patient information than presented within this dashboard is necessary, as these are also discussion moments” - Doctor

► Improving clarity and comfort

During the MDT, the dashboard succeeded in presenting the relevant patient data that needed to be handed over. Furthermore, the overview presented in the quadrant immediately made clear why some patients were discussed during this meeting, as these patients appeared as the most critical ones. Furthermore, it was commented that the dashboard made the doctors more comfortable during the handover. It often happens that doctors are being called or walk in and out of the handover room, often resulting in missing some information that is vocally shared. Since dashboard presents a decent summary, it was still possible to follow what was mentioned about each patient. On top of that, the patient data presented on the dashboard turned out to support the doctors in telling their story in a more structured way.

“The patient overview immediately clarified the choice of patients discussed during the MDT” - Doctor

► Instability can be interpreted in multiple ways

The test provoked some discussion regarding the y-axis of the quadrant, presenting the instability of each patient. According to the doctors, this word is ambiguous, as this term can be interpreted differently by different doctors. Suggestions were to replace this subjective parameter with an objective one, which can be measured by data in the PDMS, or to divide the y-axis in three different parts: can go to other unit – stable – unstable, as patients are mostly unstable when entering the ICU, and ready to leave to a regular unit when making enough progress. To define the actual value of the y-axis, more user tests and discussions with the doctors’ as well as nursing team are necessary to reach consensus about this.

“What is meant with instability, and how do you make sure that everyone interprets this in the same way?” - Doctor

“I REALLY LIKE THE APPEARANCE OF THE DASHBOARD INCLUDING THE SUPPORTIVE ICONS”

- Doctor

Evaluation with nurses

► Improving efficiency and effectiveness

The designed dashboard supported the shift change of the nurses in terms of effectiveness and efficiency. The nurses listening to the handover appreciated the fact that they were able to see the most important information on the screen. Because of that, the nurse giving the handover could efficiently click through the patients on the overview. Moreover, the nurses agreed that they were able to immediately have an impression of the patient population, making the division of the patients more effective. However, it was mentioned that the location of the screen in the nurses' room was not optimal, causing that not everyone was able to see the dashboard properly.

“I liked to look at the screen to follow the handover given, however, the screen needs to be put on a different wall to make it optimally visible for everyone”- Nurse

► Only providing basic patient information

Currently, lots of irritations arise because of too elaborate handovers caused by too elaborate documentation. Compared to this current way of handing over, the designed dashboard allowed for less space to insert patient information, which was appreciated by the nurses. The information presented on the dashboard was enough to be able to divide the patients.

“It was nice that all the usual prose was omitted, and everything was written down briefly and concisely” - Nurse

► Knowing the stability is very useful

In contrast to doctors, no discussion about terminology used in the dashboard arose. In fact, the nurses seemed to exactly know what was meant with 'stability' and 'instability'. When preparing the shift change with the responsible nurse, she explained that the instability axis actually tells her how much attention a patient needs, how often she will have to walk into and out of a patient's room.

“The instability shows how often I have to walk into and out of my patient's room. I think that is very valuable to know when dividing the patients during a shift change”- Nurse

► Room numbers need to be added in overview

It was mentioned by all the participating nurses that the room numbers of the patients are missing in the current overview, as an important factor for a proper division is the location of each patient. In case a nurse has to care for two

patients simultaneously, it is crucial that they are located near to each other. The nurses suggested to put a small room number under each name in the quadrant.

“We want to know how far apart the patients are from each other when we are dividing the patients among the nursing team” - Nurse

► Expected admissions were currently missing

Instead of only handing over the patients that are currently admitted to the ICU, the nurses also handover expected patients, which are often planned, post-operative patients. As these patients also need to be divided among the team, the patient overview can be made complete by adding these expected admissions as well. It was suggested to put them on top presented by a grey circle.

“When I was giving the handover, I was missing the expected incoming patients. There also has to be cared for them during the coming shift, so it is important to not forget them” - Nurse

8.2.3 Conclusion

The evaluation in practice showed that the dashboard 'overzien' supported the patient handovers of the doctors and nurses in different ways. The main advantage compared to the current situation turned out to be the quadrant showing the patient population, which improved the communication about the patients and simultaneously the amount of information that was shared. Furthermore, the brief presentation of the patient information made it more comfortable for the listeners to follow the handover, and supported structured communication by the sender. During the user test, some usability issues arose, such as the terminology used, the size of certain text boxes, the location of the screen, and the information presented. These were slightly different for the doctors and nurses and will be pointed out further in the next chapter.

“THE INSTABILITY SHOWS HOW OFTEN I HAVE TO WALK INTO AND OUT OF MY PATIENT'S ROOM. I THINK THAT IS VERY VALUABLE TO KNOW WHEN DIVIDING THE PATIENTS DURING A SHIFT CHANGE”

- Nurse

Figure 46: Impression of the evaluations in practice.



8.3 FUTURE RECOMMENDATIONS

Based on the evaluation studies, it could be concluded that ICoon enhances the patient handovers within the ICU in several ways. However, it is still a concept that could use multiple iterations to become an optimally designed service for the ICU. Thereby, compliance needs to be ensured. Consistent compliance with guidelines can significantly improve patient safety and quality of care. Barriers to compliance include unawareness or unfamiliarity, disagreement over guidelines, ineffective inter-provider communication, high workload and failure of the ICU culture to adapt to a new practice (Gurses, et al., 2008). The recommendations listed below are based on the findings during the evaluation and related to ensuring compliance:

► Possibility to update

There should exist the possibility to bring the information presented in 'overdragen' up to date, as ICoon aims for change. This can for example be realized by creating an adjustable PDF which is editable on the LUMC computers. Also, a document of 'overdragen' especially created to be used digitally needs to be created and uploaded to the protocol database, to make sure the information can always be consulted by everyone.

► Re-arranging the handover rooms

During the fieldwork, it was discovered that the physical environment has a strong influence on each meeting. This includes the location of the computers, table, chairs and central screen. Furthermore, the availability of several artefacts can determine the content of a meeting. Therefore, the screen presenting the dashboard should be allocated in such way that it is clearly visible for everyone sitting around the table. Furthermore, to encourage the team to collectively sit around the table, it is important that the computer screens are not pointed towards the walls, but rather allow eye contact. This can for example be realized by using smaller computers or tablets on the table.

► Adjusting some elements of 'overzien'

The dashboard 'overzien' requires some small adjustments to become optimally designed for the ICU. For the nurses this includes implementing room numbers in the overview and provide space for expected admissions. For the doctors this includes redefining the term 'instability' to avoid ambiguities, providing more space for the patient information when clicking on a patient, and inserting some space for the history of the patient. Besides, it should be figured out how a functional dashboard can be implemented in the PDMS the ICU is currently using.

► Offer education regarding the handovers including ICoon

Each care provider should have a clear understanding of what is expected of them regarding the usage of ICoon. To introduce ICoon to the complete ICU team, and to make sure that people comply to the tools, an educational program can be embedded in the organisation. A clear introduction or education about the tool can trigger the ICU team to regularly use the tools. On top of that, ICoon should be given to every new employee to provide them with support regarding the handovers from the beginning.

► Become more innovative by involving the people from the field

During my project at the LUMC, I learned that the hospital itself is quite conservative. I believe that when they would adopt a more innovative mindset, (especially the older) nurses and doctors will be more open to new innovations. I think that the existing conservative mindset can be reinforced by the fact that many decisions (about innovations) are currently taken top-down. However, my project demonstrates that a bottom up approach for innovations proves to work, as the involvement of the doctors and nurses made them more positive towards and willing to adopt my proposed innovation. Therefore, I would strongly recommend this involvement from the field in the future. Furthermore, the ICU can for example amplify an innovative mindset by collaborating more with other (innovative) hospitals, collaborating with different departments of the TU Delft, and inviting more (design) students to work on (graduation) projects within their hospital.

8.4 LIMITATIONS OF THIS PROJECT

The information gathered during this project in literature, during interviews, while designing, and during evaluation provides various suggestions on how to enhance the patient handovers within ICUs, resulting in one design proposal, ICoon. However, the project does have some limitations worth mentioning:

► Short-term evaluation

The evaluation of ICoon was only done on the short term: during three practical evaluations and during conversations with medical professionals over a week. However, the actual impact of ICoon and whether it has the desired effect on the long term can only be assessed over time. Therefore, practical evaluations throughout a longer period of time including regular conversations with the users would be recommended.

► Only ICU doctors and nurses were involved throughout the project

The complete graduation project and the final evaluations only included the doctors and nurses working at the ICU. However, many other medical professionals are involved in critical care (see chapter 2.4) who are also regularly present during the handover within the ICU. Nonetheless, these other medical specialists were not involved in this project. This might be interesting to do in the future, to get a more holistic view from different perspectives on ICoon and future usage.

► Homogeneous group of participants

The participants involved throughout this project came from a fairly homogeneous group. All participants were habituated in the same region and working in the same hospital, the LUMC. However, in the future it would be interesting to repeat the study in a more heterogeneous population, with as a first step involving medical professionals of ICUs from different hospitals and including peripheral hospitals as well.

► Only qualitative, subjective evaluations were done

In this project, only qualitative evaluations with the ICU team regarding ICoon were done in order to assess whether it increases the experienced effectiveness and efficiency of a handover. Besides this, it might be interesting to perform quantitative evaluations as well: Does ICoon actually make the handovers more efficient and effective? I believe this is necessary to eventually study as well, as I noticed that scientific, objective evidence of whether something works or not, can increase the willingness to implement a service like ICoon within the medical field.



9.0 CONCLUSION

The main question to be answered during this project was:

How can we achieve that the patient handovers are experienced as effective and efficient, and simultaneously realize a better shared understanding of patients' needs among the ICU team?

To answer this question, a literature study was executed, fieldwork was done, and concept proposals were developed. These activities resulted in the final concept ICoon, which was evaluated with the ICU team as a final step of this project.

Convincingly, the human-centred design approach that was adopted throughout the design process of ICoon greatly supported the development of the final design. Extensively studying the ICU, the team, and the experiences that exist regarding the handovers resulted into three usable ingredients for design accompanied with different insights: information sharing, team dynamics, and context. These ingredients were applied for the development of the final concept: ICoon, which aims to enhance patient handover by providing structure, overview, and reflection.

The final evaluations with ICoon revealed that the tool contributes to an increased feeling of effectiveness and efficiency of the patient handovers among the ICU team. It turned out that each component of ICoon provides a different main added value to the ICU team. 'Overdragen' provides focus, structure, and aligns expectations. Furthermore, 'overzien' brings overview, which stimulates the doctors and nurses to handover more efficiently and directly provides an understanding of the patient population. Finally, 'overhebben' can have a positive impact on the teamwork within and between the team of nurses and team of doctors.

Besides the functional role of ICoon, the tool also aims for transformation. Throughout the process, I noticed that I was not comfortable in designing a tool for the current handover organization only, but that it felt natural to think about how this organization could be changed. However, as I did not feel as the right person to do this, I discovered by creating ICoon that my task was not only to shape a solution based on the current situation, but that I was also shaping tools, skills, and the organization to facilitate ongoing change.

Aiming for ongoing change includes the intrinsic element of co-designing, which is the required for the development of the ICU team. Therefore, the adopted human-centred approach turned out to be a key element throughout this project.

This human-centred design approach involving thorough interaction with the ICU team led to relevant ideas, concepts, and one final concept. The involvement was not only entailed by the interviews and observations, but also by investing in the relationship with the ICU by being physically present, by talking to them in the corridors, by leaving artefacts I made physically behind (the posters visualising the interview results), and by involving them in activities as concept evaluations, a presentation, a session, and different evaluations. Thereby, this project demonstrates that a bottom up approach for innovations within a hospital proves to work, as the involvement of the doctors and nurses made them feel positive about and willing to implement my proposed innovation.

All in all, looking back at the research question, ICoon supports the experienced effectiveness and efficiency of patient handovers at the ICU. Furthermore, especially the designed dashboard 'overzien' allows for a better understanding of the patient, the patient population and the existing needs. However, the human-centred approach rather than this concept might be the actual answer to the question. By adopting a human-centred design approach, suitable concepts can be co-created that support the patient handovers.

ICoon was especially created for the ICU at the LUMC. Other hospitals might have slightly different needs. So, when designing for enhanced patient handovers, the learnings of this project can be used, but a human-centred approach is still necessary to cause transformative change within a hospital organization.

The combination of the concept ICoon with the involvement of the ICU team resulted tools and capacities for the realization of innovation at the LUMC. I left my vision, so that they can continue with my work. The key of that is co-creation.



10.0 REFLECTION

“I BECAME A DESIGNER THAT HAS THE AMBITION TO WORK ON HEALTHCARE-RELATED CHALLENGES TO IMPROVE PEOPLE’S QUALITY OF LIFE, A DESIGNER THAT IS NOT AFRAID TO DIVE INTO AN UNKNOWN CONTEXT, AND A DESIGNER THAT ENJOYS EXTENSIVELY RESEARCHING THE CONTEXT, BY APPLYING, ADJUSTING, AND SOMETIMES INVENTING METHODS TO REACH MY GOAL”.

My graduation project was a completely new experience. Although I was already used to work on projects, suddenly I felt my role changed. Since I was executing this project on my own, I became a project leader, manager, and executive member all in one.

From the start of my project, I was involved in different activities within the hospital which allowed me to get a holistic view on the organization. Being a doctor and nurse for some days provided the most insightful moments and gave me insight in how (unpredictable) a day of a doctor can usually be. Attending an open-heart surgery (already the 3rd day of my project!) made the experience complete and gave me insight in a doctor’s and nurse’s routine, their ability to quickly adapt their planning, and their casual way of dealing with such heavy and emotional situations. By involving myself in the different activities of ICU doctors and nurses, I got the insight that this is a very good way to build a relationship with them. I noticed that it is very important to invest in this relationship. The fact that they knew and trusted me resulted in many people willing to participate in my studies and the possibility to record pictures of each activity as well.

Since contextmapping was the main approach during the first part of my project, I was able to apply the knowledge I gained during my previous internship at Muzus. I was surprised about the fact that everyone seriously filled in the sensitizing booklets and reserved enough time to do a proper interview. The fact that I heard enthusiastic replies from some doctors and nurses about my approach happily surprised me even more. I learned that adjusting the sensitizing materials to the user, including carefully considering the layout and content of the sensitizing package contributed to their commitment a lot. Moreover, I got the insight that the results from the observation study were very useful to implement within the set-up of the interviews, as making my already

acquired knowledge explicit in my questions caused that the interviews could really go into depth.

During the interviews for the fieldwork as well as for the evaluations, I saw that it was sometimes difficult for the doctors and nurses to express how they felt and what their own experiences were during different handovers. Instead, they tended to share facts or talk about others’ opinions. Therefore, I learned to adopt a more assertive attitude during the interviews, asking further and further until the participants were able to express themselves in the desired way.

One of my learning goals was to make the ICU team understand the value of my research and approach as a designer. One of the challenges that I was foreseeing was the need to convince the ICU team that a designer can be a very valuable addition in their context. However, now the project came to an end, I believe that I convinced many doctors and nurses about the value of a designer. For example, I triggered the PDMS expert to think about a lot of new plans and ideas for optimizing the system for handovers, and the responses during the different activities I did with the ICU team were always positive in the end. I can happily say that my project definitely had impact, which will hopefully continue when I am gone with the tools I left.

My bachelor’s degree was obtained at the department of Industrial Design at Eindhoven, University of Technology. From my point of view, the program here focused more on the development and application of a new product, service, or system that was created during a project. The approach was always very free, which made me comfortable with unknown and unstructured challenges. However, here in Delft I noticed that there already exists lots of methods which you can apply in a design process in order to get there. As I firstly was inventing my own methods to come to

a final design, I now learned that these methods are here to support this process, and that using them prevents you from continuously re-inventing the wheel. For this reason, I feel that my work also became way more academic during my studies in Delft. Therefore, combining the freer approach I learned in Eindhoven with the stricter approach obtained in Delft turned out to be a fruitful combination. Furthermore, the combination of studying both in Delft and Eindhoven made me the designer I am now: a designer that has the ambition to work on healthcare-related challenges to improve people’s quality of life, a designer that is not afraid to dive into an unknown context, and a designer that enjoys extensively researching the context, by applying, adjusting, and sometimes inventing methods to do this.

All in all, I can say that I am happy with the end result of the project and the process towards that, as I actually enjoyed every phase of it. Therefore, I definitely started to feel more confident in doing such projects (on my own), although I still prefer working in a (multi-disciplinary) team. I discovered that I really enjoy doing research, to keep on digging in a subject from different perspectives to eventually come up with a theory and suitable solution. Accordingly, I think I am ready for the professional world, in which I would really like to have a role as designer-researcher.

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