Designing for Nurse-AI Collaboration in Triage

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Abstract

The Local Emergency Medical Communication Centers (LEMCs) play a crucial role in the Norwegian healthcare system by receiving calls for immediate medical assistance. Registered nurses operate the phone calls, and their task is to assess the situation and triage the caller into appropriate triage levels indicating when and how help should be provided. Telephone triage poses challenges due to the limitations of audio communication, time sensitivity, and complex decision-making. Additionally, nurses often face the burden of managing clinical tools across multiple interfaces.

This thesis explored how to design a system to support nurses in telephone triage and how we can facilitate nurse-AI collaboration in the process. A Research through Design (RtD) methodology was employed, and an iterative design approach was utilized. The research investigated the design aspects of AI-based suggestions and the use of natural language when creating semi-structured documentation. Four prototype iterations were developed throughout the study, and researchers from RE-AIMED and telephone operators conducted evaluations of the prototypes.

Designing a tool for telephone triage requires understanding the user's needs and workflow. It is, therefore, crucial to involve telephone operators in the design process. The prototype demonstrated how we could design for incorporating AI in the triage process, and this thesis explores the various considerations when designing for nurse-AI collaboration. One notable finding was the importance of enabling documentation in natural language, as relying solely on structured documentation may fail to capture the caller's specific situation. Additionally, it is important to design a system that facilitates documentation of patient-initiated information and questions initiated by the nurses or the system.

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Chapter 1

Introduction

The Local Emergency Medical Communication Centers (LEMCs) are a part of the out-of-hour emergency primary health care service (OOH service) and receive telephone calls for immediate medical assistance. It plays a crucial role in the Norwegian health-care system, as citizens are encouraged to call the LEMCs before visiting emergency primary care centers directly (*Helsenorge.no*, 2023). The phone calls are usually handled by registered nurses (*Raknes et al.*, 2017) and are used to assess the situation and allocate an urgency level. This initial assessment is done to prioritize patients with more urgent problems and to guide the patients to the correct level of care at the right time. Telephone triage poses challenges due to the limitations of relying on audio communication, the time sensitivity of the process, and the complexity of making accurate decisions. Additionally, the nurses often have to deal with different tasks at once (*Berge et al.*, 2023). Two of these tasks include clinical documentation and utilization of triage support tools. In Norway, the various system to accomplish these tasks are often independent and lack interoperability (*Heimestøl et al.*, 2019). As a result, the operators must interact with multiple interfaces, which can steal attention from the caller and the conversation.

Nurse documentation is usually written in unstructured free text, filled with variations in wording, spelling, and descriptiveness across different providers (*Greenbaum et al.*, 2017). The documentation has, therefore, little visible structure that can help the nurses to get an overview of the patient's medical condition as well as to restructure the documentation. Furthermore, this form of documentation can pose challenges for real-time support in triage and decision-making processes, as it can be difficult for systems to interpret and analyze such input.

Clinical decision support systems (CDSS) can be utilized to support the triage and decision-making process. These systems help ensure that relevant questions are asked, support the nurses when deciding, and help make more consistent decisions among the operators. Nevertheless, the perceived rigidity of these systems can present challenges by potentially compromising nurses' autonomy and creating a mismatch between the design of the system and the natural flow of a conversation.

To address this dual duty of documenting simultaneously as navigating triage support tools *Berge et al.* (2023) proposes a way to incorporate these tasks within one interface and utilize artificial intelligence in the process. Artificial intelligence can support users with knowledge-based and patient-specific information and help the users to identify hidden patterns (*Lai et al.*, 2021). While significant attention in the literature has been on the performance of AI-based medical systems, exploring how we can support the interaction between nurses and AI is equally crucial. However, our understanding of the context, design, and psychological mechanisms necessary for creating an ideal human-AI collaboration are currently limited (*Reverberi et al.*, 2022).

This thesis utilized an iterative design approach to explore how we can support the nurses during triage and how we can design for nurse-AI collaboration. The research was conducted in collaboration with RE-AIMED, and their prototype was used as a starting point in the design process. The research in this thesis intends to design and develop a prototype that assists nurses during triage while investigating how we can support nurse-AI collaboration. This research will contribute by producing an artifact and a discussion about considerations when designing to support both triage and nurse-AI collaboration.

This thesis aims to investigate the design aspects to support telephone operators in the triage process through AI-based suggestions and semi-structured documentation. Additionally, it will explore the use of natural language in the process. The research questions of this thesis are:

RQ1: *How can we design for supporting telephone triage with AI-based suggestions and semi-structured documentation?*

RQ2: *How can a triage tool facilitate the use of natural language in the process of creating semi-structured documentation?*

To address the research questions, relevant topics and literature within the domain of telephone triage will be covered. The findings from the literature, along with the insights from both the RE-AIMED team and prototype, formed the basis of the design process. The development of the prototypes was an iterative process, including evaluations and establishing requirements. Design critiques involved researchers from the RE-AIMED project, while interviews and evaluation of the prototype using walkthroughs included telephone operators. The evaluations provided valuable insights that informed additional requirements for the prototype.

1.1 Thesis Outline

Chapter 2 Presents relevant background and literature related to the work in this thesis.

Chapter 3: Presents the methodology and methods used in the research process.

Chapter 4: Describes the two initial phases of the design process, and presents the tools used, defining the project scope and the first initial sketches. The RE-AIMED prototype is then evaluated, and a second iteration of the prototype is presented.

Chapter 5: Describes the third and fourth phases of the design project, design critique, and evaluating the prototype with users.

Chapter 6: Presents the final prototype.

Chapter 7: Provides a discussion of the results, the prototyping process, user evaluation, and answers the research questions.

Chapter 8: Presents the conclusion of this thesis and future work.

Chapter 2

Background

This chapter focuses on topics relevant to the master thesis. As a starting point, the concept of telephone triage will be explained, followed by an overview of the Norwegian healthcare system and the out-of-hours (OOH) service. Subsequently, it will provide an overview of the triage tools utilized in the Local Emergency Medical Communication Centres (LEMCs) in Norway and an exploration of the different phases that comprise telephone triage. Additionally, the chapter includes a review of clinical decision support, symptom checkers, and clinical documentation. It explores the integration of artificial intelligence (AI) in healthcare and how it is used or could benefit from being used in the future. Lastly, it introduces human-computer interaction (HCI) and human-AI collaboration.

2.1 Telephone Triage

Triage – a French word meaning "sorting" – refers to the process by which health professionals in the emergency department categorize patients by level of emergency so that those in most need of treatment will be assisted first (*Abad-Grau et al.*, 2008). The term triage was originally used to prioritize the care of injured soldiers in war but has become a common practice in modern healthcare (*Ryan*, 2008). The term telephone triage is, as the name suggests, the process of conducting triage over the phone. Telephone triage is usually handled by nurses and entails a complex human interaction between the caller and the operator (*Kaakinen et al.*, 2016). The primary purpose of telephone triage is to identify the callers with the most need for care by allocating appropriate urgency levels (*Erkelens et al.*, 2021). This is done to ensure that the patients in most need of medical assistance get help first. In addition, the nurses guide the patients to the right level of care and provide guidance and healthcare advice for their symptoms.

Telephone triage increases accessibility to healthcare and allows patients to receive medical advice and guidance from anywhere in the country. In the cases where patients experience mild or non-urgent symptoms, the nurses can assess their symptoms over the phone and thus avoid unnecessary visits to the emergency primary care centre. In addition, the COVID-19 pandemic has highlighted the importance of telephone triage in managing the sudden increase in healthcare-seeking behavior. Where it was crucial to minimize face-to-face contacts (*Pairon et al.*, 2022). However, the process of telephone triage can present challenges, as healthcare providers are limited to using only oral communication and may have limited time to assess a patient's needs (*Kaakinen et al.*, 2016).

2.2 Norwegian Healthcare System and Out-of-Hours Service

The Norwegian healthcare system is composed of primary care and specialized care services. Four Regional Authorities have responsibility for specialist care, while the municipalities are responsible for primary care. Norway has two types of communication centers that support the delivery of emergency care services. At the level of specialized care, there are Emergency Medical Communication Centers (EMCC). EMCC provides ambulance transport to individuals in need of urgent medical attention. While primary care supports emergency care services through the out-of-hour service (*Sperre Saunes et al.*, 2020).

Primary care also includes services such as general practitioners (GPs). During office hours, the GPs are responsible for providing the necessary care and immediate assistance to patients (*Helse og omsorgsdepartementet*, 2023a). In cases where immediate medical attention is required outside of office hours, individuals can contact the Local Emergency Medical Communication Centres (LEMCs) by calling the national telephone number 116 117. This service is free to call for all citizens and is available 24/7. Patients can call the number from anywhere in the country and will be connected to the nearest LEMC based on their current location. The LEMC is usually staffed with registered nurses (*Hansen and Hunskaar*, 2011).

The municipalities are responsible for ensuring 24/7 access to immediate help for everyone in the municipality (*Helse og omsorgsdepartementet*, 2023b). The organization of the OOH service varies depending on democratic and geographic factors, and the municipalities can cooperate on the service. In 2022, there were a total of 168 emergency primary care centers in Norway, comprising 83 inter-municipal clinics and 85 municipal clinics. Additionally, there were 94 LEMCs (*Allertsen and Morken*, 2022).

Most patients contact the OOH service by phone, and for many places, this is the only available contact method. While in larger cities, patients can directly visit the emergency primary care center (*Midtbø et al.*, 2017). However, direct attendance is not recommended, and it is preferred that patients call ahead (*Helsenorge.no*, 2023). The OOH service commonly experiences a high volume of telephone calls from citizens seeking medical attention (*Eikeland et al.*, 2017). There are times when the Local Emergency Medical Call Centers can become very busy. Usually, 40% of the contacts in the LEMC take place on the weekends, while 60% occur during the five weekdays. Holidays such as Easter and Christmas also tend to be very busy (*Sandvik et al.*, 2022). It is, therefore, important that each inquiry should be evaluated according to its urgency so that the patient can be prioritized accordingly. This assessment is used to triage the patients. During the initial assessment, patients can receive advice and information about their symptoms. Given that approximately three-quarters of the calls to the LEMCs concerns minor illnesses, help over the phone can be sufficient for some patients (*Helsenorge.no*, 2023, *Raknes et al.*, 2017).

Registered nurses operate telephones in the LEMC, and their task is triaging callers and providing healthcare accordingly. As an aid in this process, the nurses use tools such as triage support to help them categorize patients according to the level of urgency and determine what help to provide and when to provide it.

2.2.1 Triage Tools Utilized in Norway

There exist several different systems that can aid the nurses when deciding the triage level and assessment of patients. Some are developed to handle inquiries by phone, while others are for face-to-face encounters. According to a national mapping from 2018, multiple LEMCs in Norway utilize various triage tools. These include internationally recognized systems such as the Manchester Triage System, as well as Norwegian-developed tools such as the Norwegian Index for Medical Emergency Assistance (*"Norsk Indeks (NIMN)"*) and the Local Emergency Medical Communication Center Index (*"Legevaktindeks"*), previously known as Telephone Advice (*"Telefonråd"*) (*Morken et al.*, 2019). The three triage tools mentioned are all designed to provide a standardized approach to triage. However, it's important to note that these tools do not take individual patient information such as gender and age into account. Consequently, nurses are required to rely on their clinical judgment to assess what is relevant for each specific situation.

Manchester Triage System

The Manchester Triage System (MTS) is a decision support tool designed to evaluate the urgency of patients presenting at the emergency departments and is the most widely used triage system in the UK, Europe, and Australia (*Mackway-Jones et al.*, 2013). It was created in the mid-1990s and was originally developed as a system to perform attendance triage. The MTS has since been expanded to include a module for telephone triage. The telephone triage component, known as the Manchester Triage System Telephone Triage and Advice (MTS TTA), consists of 53 flow charts categorized into four urgency levels. The first three levels indicate when in-person medical attention is required, while the fourth level provides advice-only guidance (*triage group*).

The Norwegian Index for Emergency Medical Assistance

The Norwegian Index for Medical Emergency Assistance (NIMN) is a criteria-based guideline used to set the urgency level and determine the appropriate measures to take. This tool is designed for time-sensitive cases, and it is used in Emergency Medical Communication Centers, but it is also used in out-of-hour service (*Helsedirektoratet*, 2020). The tool consists of a start page to collect important information such as the caller's location, contact information, and a brief question of the problem. The operator then decides if there is a need for immediate help; if not, the operator moves to the proper chapter to explore the situation further. The operator has 32 chapters based on situations and symptoms to choose from. The chapters contain a list of discriminators ordered by urgency (*Ellensen*, 2017). The system consists of three triage levels, red (*acute*), yellow (*urgent*), and green (*regular*).

Legevaktindeks

The decision support tool called "Legevaktindeks" is specifically developed for the LEMCs and is a further developed version of the support tool previously called "Telefonråd". The tool supports the first contact with the patient and helps to structure the conversation by including important questions to ask, when to direct the patient to a doctor, and advice to give in the case patient does not need a doctor's appointment (*Helsedirektoratet*, 2020). This resource is available online and is accessible to everyone (*NORCE*, 2020). The tool consists of two different reference works, one consisting of advice to give to the caller and NIMN. Similar to NIMN, this tool includes a start card that can be used as a template to initiate and guide the conversation, see Figure 2.2. It includes information on how to start the conversation and what measures to take in an emergency. If it is not obvious that it is an emergency, the "start card" instructs the telephone operator to select the most appropriate chapter, for example, "allergy", see Figure 2.1. Each chapter includes a set of questions to ask for a given symptom. The questions are asked, from top to bottom, to exclude the most urgent cases first. The triage levels in this system are the same as in NIMN. Within the chapters, the user can click on the heading in the text frame and can see the corresponding discriminators from NIMN.

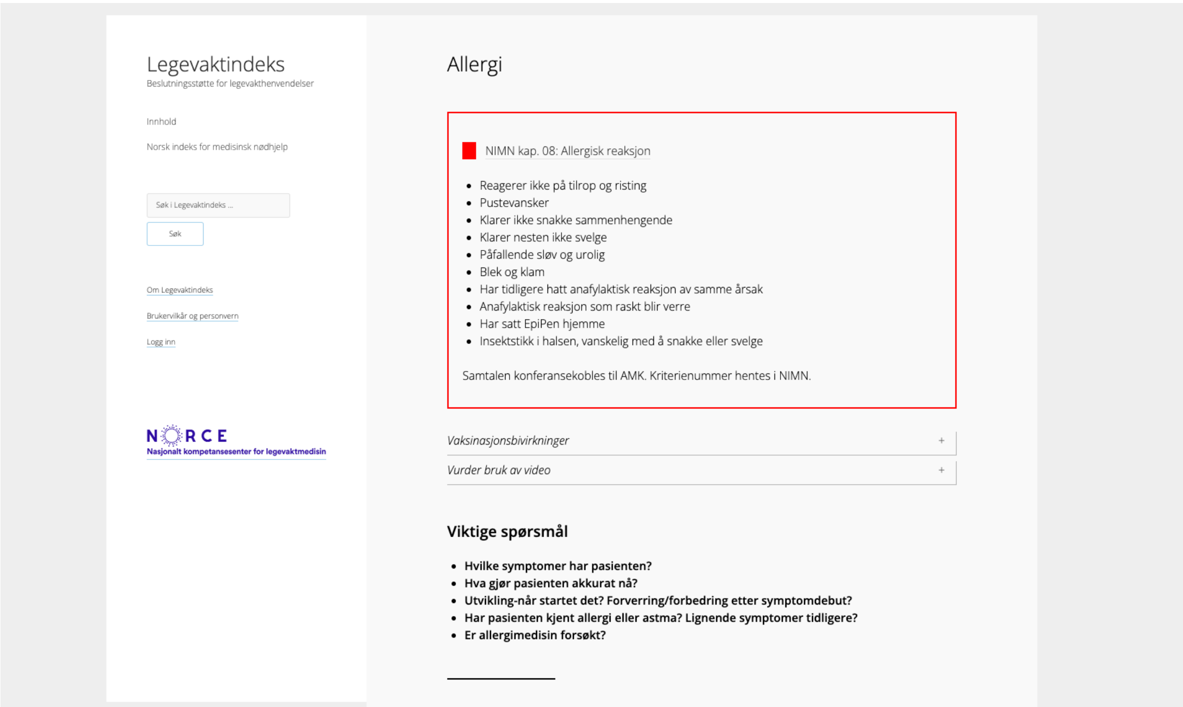

Figure 2.1: Legevaktindeks - chapter "allergy", NORCE (2020)

2.2.2 Documentation

Telephone operators in Norway are required by law to document the patient's call, and the documentation should include relevant and necessary information about the patient and the health help given (*Helsepersonelloven*, § 39). The operators typically document the conversation in a free text (*Berge et al.*, 2023). Nurses need to document during triage because it records what was said and done during the conversation and what and why decisions were made. Documentation of the conversation can be useful for future events, such as understanding previous encounters in the case of re-contact and complaints. In the event of a complaint, the documentation serves as proof of the health assistance given. In addition to the nurses having to document the conversation, the LEMC is also required by law to have an audio log of the conversation (*Akuttmedisinforskriften*, § 13). The documentation is, therefore, useful for the nurse who writes the documentation and other health professionals that will continue giving medical assistance. In Norway, there is an obligation to give patients access to medical records if they request this, as well as an explanation of the clinical terms used (*Helsepersonelloven*, § 41).

The telephone operators mainly document the conversation due to legal grounds as well as to ensure patient safety. However, the documentation itself may serve as a tool during the conversation. It works as a note to keep track of what has been asked previously and can help the nurses to get an overview of the situation.

2.3 Phases of Telephone Triage

The LEMCs handle a wide range of problems and patients. This requires the nurses to tailor their conversation and way of working depending on the situation. However, the nurses performing the triage generally follow a guide. The section below presents telephone triage phases identified in the literature.

Berge et al. (2023) identified six phases that are often present in the conversation between the caller and the telephone operator in Norway. These phases include gathering personal data, formulating the problem, exploring symptoms, providing a response, operator advice, and conducting follow-up work. When the telephone operator answers the call, they first want to collect personal information such as their name, identification, and location. The patient then presents their primary reason for contacting the LEMC, often referred to as the chief complaint. If the nurse determines that the situation is not a severe emergency, they will proceed to explore the patient's symptoms. In this phase, exploration of symptoms, if the nurses are utilizing a support tool, it involves selecting the right chapter and asking questions from the given chapter to gather more information and to clarify whether it is an emergency. After the exploration of the symptoms, the nurses will then select the urgency level and response.

Personal Data	Problem Formulation	Exploring Symptoms	Response	Nurse Advice	Follow-Up Work

Table 2.1: The identified phases from Berge et al. (2023)

Erkelens et al. (2021), studied telephone triage conversations in the Netherlands and identified seven phases that are present in the triage process in out-of-hours service in primary care. These include opening the conversation, establishing the reason for calling, checking the safety of the caller, registration, collection of medical information, action to be undertaken, and lastly, closing the conversation. The study highlights that the allocation of urgency is primarily influenced by phases three and five, which consist of collecting medically relevant questions.

Opening	Establishing the reason for calling	Checking the safety of the caller	Registration of the caller	Collection of additional medical information	Plan or action to be undertaken	Closing

Table 2.2: Identified phases from Erkelens et al. (2021)

Greenberg (2009) conceptualization of telephone nursing involves three stages: information gathering, cognitive processing, and output. Although this model was initially developed for telenursing as a whole, the three phases can also be applied to the telephone triage process.

Following these phases, the nurses have to formulate questions, interpret responses, navigate through the triage support systems they are using, and document the responses given by the patient (*Erkelens et al.*, 2021). This requires the nurses to navigate many tasks at once. *Berge et al.* (2023) highlights a challenge with the Norwegian triage system: the triage support systems are not integrated into the interface where nurses document the patient encounter. This means that nurses must navigate between two separate interfaces while performing two different tasks. During the problem formulation and exploration of symptoms phases, the documentation process is most prominent, while the triage system is used the most during the exploration of symptoms phase. As a result, nurses are required to simultaneously perform two tasks in two different interfaces, which can be time-consuming and can steal focus from the conversation with the caller. The nurses document the encounter using a plain text input field. This documentation commonly includes the patient's symptoms, response, and advice given and is written manually by the nurses (*Berge et al.*, 2023). While this type of documentation allows the nurses to use the ease of natural language (*Greenbaum et al.*, 2017), it also results in documentation that lacks standardization (*Sun and Loparo*, 2019).

2.4 Clinical Decision Support

Triage is a critical process in healthcare, and an essential part of triage is to determine the appropriate triage level for each patient. Nurses use various tools to help them make this decision, but the term "clinical decision support" in a triage setting is used differently in the literature. The term is used to refer to a variety of tools and interventions, both computerized and non-computerized (*Wasylewicz and Scheepers-Hoeks*, 2019). It is therefore important to clarify the meaning of these concepts before moving on.

Zhu et al. (2022), defined the concept Clinical Triage protocols as *"documents which serve to guide administrators and clinicians making decisions to partition and allocate care in times of scarcity"*.

While Clinical Decision Support Systems (CDSS) refer to systems that provide clinicians or patients with clinical knowledge and patient-related information, intelligently filtered, and presented at appropriate times (*Teich et al.*, 2005).

Both of these concepts seek to aid the nurses in their decision-making process. However, the main difference between clinical triage protocols and decision support tools is that triage protocols are a set of guidelines and procedures that are applied to all patients, while clinical decision support systems tools are more individualized and can provide specific suggestions for each patient (*Castillo and Kelemen*, 2013). The use of one does not necessarily preclude the use of the other, and they can be employed at different stages of the triage process. Triage protocols are typically used as a first step in the triage process, to determine which patients require immediate attention. While clinical decision support tools are used to refine the decision-making process to aid the nurses when exploring the symptoms and to ensure that the patients receive the most appropriate care. Figure 2.2 shows the Triage protocol from the Norwegian Index. The triage tool Legevaktindeks also has a similar triage protocol (*Sandvik et al.*, 2022).

A clinical decision support system is designed to help healthcare providers make better decisions by providing them with clinical knowledge and patient-specific information (*Sutton et al.*, 2020). It is a type of software that allows the user to enter patient-specific information which the system interprets (*Castillo and Kelemen*, 2013). The benefits of these software programs are greater consistency and reliability in the assessment and for giving advice (*Holmström*, 2007, *Tariq et al.*, 2017). Additionally, they can make the documentation process easier (*Sadeghi et al.*, 2006) and improve clinical notes (*North et al.*, 2014). The use of CDSS can reduce cognitive workload for the nurses by serving as a memory helper to ensure that all relevant questions are asked (*Holmström*, 2007). It can also be complementary support for the nurses when they are faced with situations and problems where their own clinical knowledge and experiences are limited (*Ernesäter et al.*, 2009).

All clinical decision support system aims to help healthcare providers to make more informed and accurate decisions. While these systems aim to give similar output, the basis of the systems may vary. CDSS are frequently classified as knowledge-based or non-knowledge-based (*Sutton et al.*, 2020).

Knowledge-based systems are designed to provide decision support by leveraging the collective knowledge and expertise of human experts. Some examples of this category are protocol-based CDSS and clinical decision rules. Protocol-based CDSS uses pre-determined protocols to guide a healthcare provider when making decisions. The protocols typically include a set of steps that the provider can follow to assess the patient´s condition and determine the appropriate course of action. Clinical decision rules as the name suggest, use a set of predefined rules to guide the healthcare provider. The rules are typically based on expert knowledge, humans within the field, and the rules generally follow an if-then format (*Wright and Shiffman*, 2013).

Unlike knowledge-based CDSS, non-knowledge-based CDSS does not rely on rules. Instead, they use artificial intelligence or machine learning to identify patterns in the patient's current state and then use this information to help make decisions (*Somashekhar et al.*, 2018).

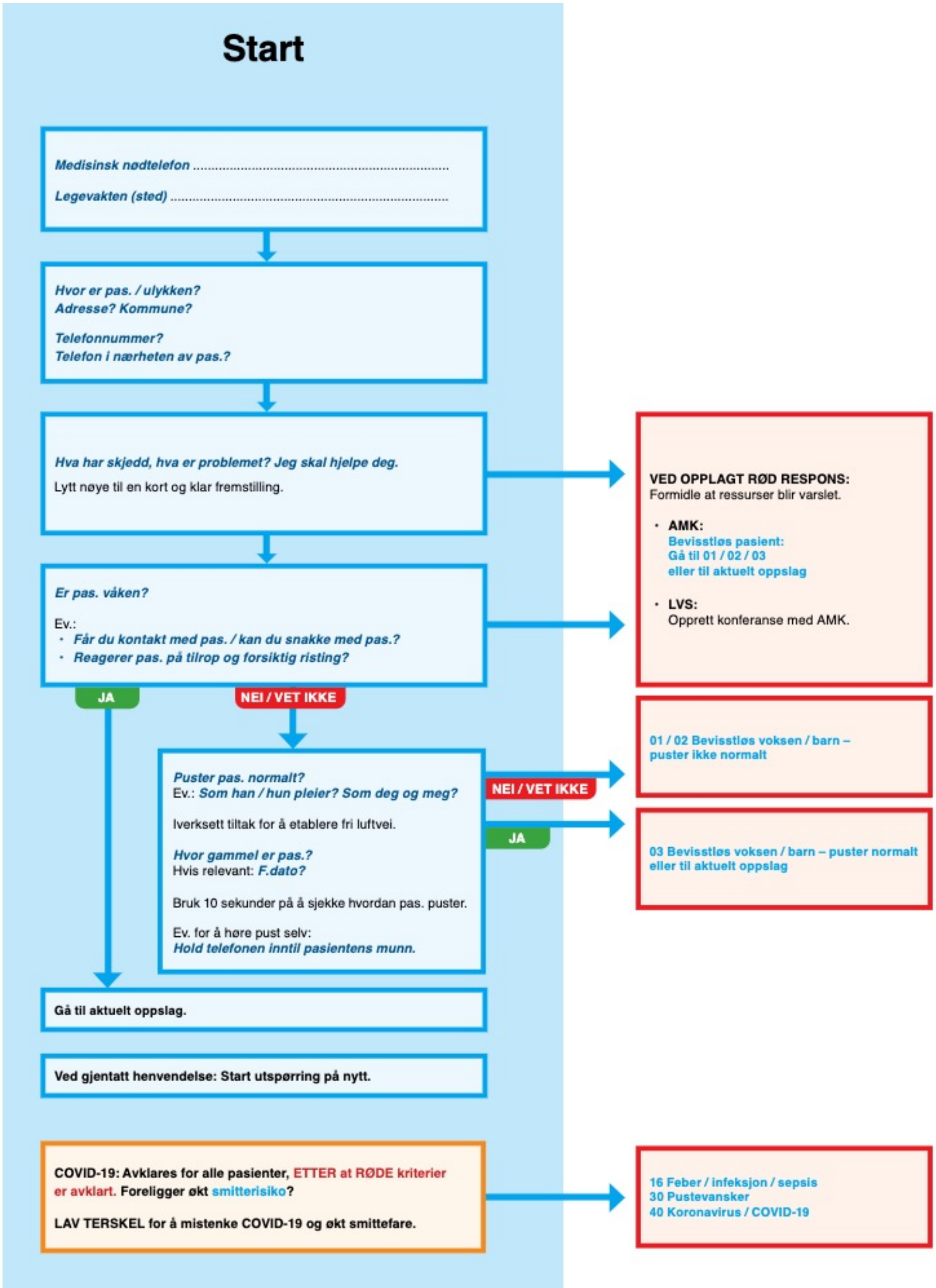

Figure 2.2: Triage protocol from Norwegian Index (NORCE, 2020)

2.4.1 Challenges

Murdoch et al. (2015) analyzed the use of a CDSS in telephone triage. They identified that this system could impose constraints on the nurses questioning process by having to follow a predefined path. In the system they evaluated, the nurses had to select a symptom to launch the CDSS, the patient's chief complaint. This action led them to a series of symptom-related questions. However, if the patient presented another symptom or problem, the nurses were forced to decide whether to complete the set of questions or to launch the CDSS again with another symptom. The system is therefore designed in a way that limits the nurse's ability to explore different symptoms and thus can limit patient-initiated input.

Decision support that uses a rigid hierarchical design or questions is also seen as a challenge (*Tariq et al.*, 2017). The rigid hierarchical design can force the nurses to answer all the proposed questions, which can be difficult if the nurses cannot obtain the information, especially if they cannot select *"unsure"* (*Horwood et al.*, 2023). *Ernesäter et al.* (2009) also found that a rigid CDSS system can inhibit the nurse's professional autonomy and that the nurse's expertise was not used to their full potential. It could result in the nurses feeling passive and forgetting to ask or give advice that is not in the CDSS. Additionally, rigid questions can make it difficult to accurately document what the patient experience if their response does not match the predetermined response options (*Murdoch et al.*, 2015).

It has been identified that nurses may not use CDSS as intended. The goal of these systems is to aid the nurses when making a decision. However, *Holmström* (2007) found that the nurses used these systems to support the assessment, but not for decision.

Clinical decision support systems have been extensively researched, with a focus on developing accurate and reliable underlying models and algorithms (*Miller et al.*, 2017). However, there are challenges with the acceptance and use of CDSS and poor usability has been identified as a barrier to CDSS reaching its full potential (*Salwei et al.*, 2022). While the rise of this system was to simplify the workflow and make some tasks easier to accomplish, the lack of focus on usability could result in negative consequences. *Cho et al.* (2022) proposed that poor usability in health technologies such as EHR (Electronic Health Records) is associated with increased cognitive workload, clinical burnout, and work inefficiency.

2.5 Symptom Checkers

Another tool utilized within healthcare is symptom checkers. These are directly geared toward the patients and seek to resemble some of the tools healthcare workers use such as CDSS, triage protocols, and differential diagnosis support tools.

Symptom checkers are algorithm-based tools for self-diagnosis and self-triage (*Morita et al.*, 2017). These can be a convenient and valuable resource for persons to understand their health concerns. *Razzaki et al.* (2018) identified three reasons why patients utilize symptom checkers. Firstly, symptom checkers can serve as a source of information regarding their symptoms or the conditions they think they have. Secondly, the patients may want to know whether their symptoms require treatment. The symptom checker can therefore work as an aid to help the patients when deciding whether to seek in-person healthcare and decide what healthcare setting to visit (*Meyer et al.*, 2020). This is medical triage and involves directing the patients to the most suitable location and within the appropriate time frame (*Razzaki et al.*, 2018). Lastly, the patients may want to understand the condition that might be responsible for their symptoms or to better understand the diagnosis made by the doctor.

Most symptom checkers start with the patient filling in initial information, such as gender and age. Then, the patients select their current symptoms, either through a search or selecting them from a list. Some symptoms also allow the patient to select the location of their symptom. An example of a symptom checker is the Isabel Symptom Checker (*Isabel*). It is a free Web-based, AI-assisted symptom checker for patients. The symptom checker uses evidence-based natural language processing techniques to create a list of likely diagnoses (*Meyer et al.*, 2020). After inputting the initial information, the symptom checker may ask some more in-depth questions about the given symptoms. Symptom checker usually provides a list of possible diagnoses, often ranked by likelihood (*Semigran et al.*, 2015). Additionally, some symptom checkers may also facilitate assistance with triage (*Semigran et al.*, 2015). This triage function informs patients whether they should seek care and suggest where and with what urgency.

Symptom checkers are promising tools that provide help to patients seeking guidance on health problems (*Kujala and Hörhammer*, 2022). However, there are concerns regarding accuracy and safety (*Wallace et al.*, 2022). In a paper by *Ceney et al.* (2021), they tested publicly available symptom-checkers and used 50 clinical vignettes. These where implemented in each system by a non-clinical researcher. The findings were that the average diagnostic accuracy of symptom checkers was poor. This was also supported in the paper by *Wallace et al.* (2022). Overall triage accuracy tended to be higher than diagnostic accuracy (*Wallace et al.*, 2022). Suggested triage and triage advice are generally risk-averse, encouraging patients to seek care for conditions in which self-care would be more appropriate (*Kujala and Hörhammer*, 2022), which may induce unnecessary worry and anxiety in patients (*Ceney et al.*, 2021). Additionally, symptom checkers are often web-based or phone applications. This can make it less accessible for vulnerable groups such as older people and people with learning difficulties.

The Finnish public primary care has utilized symptom checkers to enhance triage (*Kujala and Hörhammer*, 2022). This allowed the patients to report their symptoms online and they could receive self-care instructions. Additionally, the patients had the opportunity to submit a report to the health centers. Healthcare professionals, usually nurses receive this report of the patient's symptoms, the most probable diagnoses, and the urgency level. The nurses then decide on the actions to be taken and communicate this to the patient.

2.6 Clinical Documentation

Clinical documentation is central to patient care and includes a record that summarizes the interaction between patients and healthcare providers (*Rosenbloom et al.*, 2011). This can be a time-consuming task especially when the healthcare providers must document the interaction while handling other tasks simultaneously. The information that is documented can take two forms, structured and unstructured. Structured data includes gender and age, and other inputs where the users are restricted to using a specific data entry. Unstructured data consist of data written in free text using natural language. The documentation that consists of unstructured free text can contain valuable information, and this format allows for precise and domain-specific information (*Hashir and Sawhney*, 2020).

Clinicians often prefer to use the ease of natural language (*Greenbaum et al.*, 2017). Writing documentation using natural language can be easy, fast, and possibly the best way to represent the complexity of certain situations. However, it can be difficult for computers to extract, interpret and use this information to further aid the healthcare providers in their workflow. Conventional natural language processing (NLP) methods can also be applied to extract structured features from free text. However, using these methods to automatically extract data can cause biases (*Hashir and Sawhney*, 2020).

One solution to this issue is the use of ontologies. Ontologies are a representation of the vocabulary, often specialized within some domain (*Chandrasekaran et al.*, 1999). In the field of medicine, ontologies describe the concept of medical terminologies and the relation between them (*Aldosari et al.*, 2017). Ontologies provide structure to clinical documentation, enable research, and are essential for interoperability. Additionally, they form the basis of clinical decision support systems (*Greenbaum et al.*, 2017).

2.6.1 Autocompletion

Since many clinicians prefer to write the documentation in free text, *Murray et al.* (2021) created a system that automatically captures structured data from natural language. This is done through autocompletion in real-time as well as post-recognition to recognize meaningful concepts from a large standard medical ontology. They first explored the use of a trigger character as a prefix before the word to start the autocomplete. However, this required the user's prior knowledge of what words could be used with autocomplete, and if there were no matches found they had to go back and delete the prefix. In the final system, they used a one-dimensional convolutional neural network model to predict when to trigger autocompletion and how to rank the suggestions. When autocompletion was not used, the system also relied on an algorithm to automatically identify clinical terms from the text. The words matched to an ontology using autocompletion were highlighted with different colors corresponding to different types, such as symptoms and medicine. Words matched by the post recognition are rendered with a dotted border, and the user can click on the word to see the suggestions provided and select the most appropriate ontology.

Many clinical decision support systems are built around the chief complaint of the patient, the reason for the call. The telephone operator selects the appropriate symptom or chief complaint and asks a set of questions associated with that symptom (*North et al.*, 2014). However, it can be difficult to reduce the patient problems to one symptom or the correct ontology (*Murdoch et al.*, 2015). *Greenbaum et al.* (2017) used contextual patient information such as vital signs and brief triage notes from the nurses to predict the chief complaint. Based on this information, the system predicts five chief complaints by using natural language processing and machine learning. In this manner, the chief complaint is mapped to a structured ontology which can be beneficial for further assessment.

2.7 AI in Healthcare

Artificial Intelligence (AI) is not one universal technology, but rather an umbrella term that encompasses various technologies and techniques (*Davenport and Kalakota*, 2019). It refers to the attempt to reproduce human cognitive abilities using artificial computer systems. AI systems can learn from data, identify patterns, and make decisions (*Lai et al.*, 2021). We can view the relationship between AI and healthcare as AI amplifying or augmenting human intelligence, rather than replacing it (*Bajwa et al.*, 2021). AI can improve efficiency and effectiveness and help to distribute time and resources that allow to better focus on patient and patient care. The section below, will present different tasks within healthcare that make use of AI or may benefit from its use in the future.

2.7.1 Chatbots

There is a growing trend and interest in using conversational agents in different domains and healthcare is no exception. Artificially intelligent (AI) based conversational agents also known as chatbots, are tools that can be used for different tasks within healthcare as well as healthcare purposes. Conversational agents or chatbots are computer programs that simulate conversations with users. They can converse through a range of methods such as text, image, and voice (*Tudor Car et al.*, 2020). Chatbots can be seen as a type of symptom checker that uses a conversational form that allows the patients to use natural language to communicate their health concerns (*Morse et al.*, 2020). They are often deployed via websites or social media apps such as WhatsApp (*Walwema*, 2021). These are proposed as an opportunity to tackle the challenges and barriers connected to the time restrictions many healthcare services face (*Fan et al.*, 2021).

Lai et al. (2020) argues that the healthcare industry has been a slow adopter of digital innovation. However, with the outbreak of the COVID pandemic, many healthcare institutions had to rapidly adapt to the current circumstances and sudden increase of patients (*Almalki and Azeez*, 2020, *Espinoza et al.*, 2020). Chatbots have been used in the healthcare section to support self-diagnosis and triage (*Espinoza et al.*, 2020). The use of chatbots in these tasks will be explained in the sections below.

Triage

It has been shown that AI can be used to triage patient complaints and free up primary care access for more appropriate treatment (*Lin*, 2022). As well as to provide health advice directly to the patients. To tackle the challenge of many patients during the COVID pandemic, *Lai et al.* (2020) created an AI-based chatbot that worked as the first contact between the patient and the healthcare. The chatbot was introduced to the patients while they were on hold on the COVID-19 hotline. The patients were then instructed to visit a website that hosted the chatbot and the chatbot triaged the patients into two categories: those who needed further clinical evaluation and those that did not. Using the chatbot while on hold improved the efficiency of the conversation between the nurse and caller. Both the caller and nurse had a common framework for discussion, which allowed the nurse to quickly assess and decide on appropriate actions based on mutual agreement.

Ni et al. (2017) created an AI chatbot called Mandy that interacts with patients using natural language, welcomes the patients, and provides valuable information to physicians for further inquiry. Based on the interactions between Mandy and the patient, Mandy generates a report for the doctor. The chatbot is integrated with a bigger system which also includes a desktop application for doctors. The doctor can use the desktop application to examine the patient's record as well as the report from the chatbot encounter. The symptom checker developed by Ada Health (*Morse et al.*, 2020) uses a quasi-conversational style to take basic demographic and symptoms to produce likely diagnoses and associated triage recommendations.

Self-diagnosis

Fan et al. (2021) analyzed a chatbot called DoctorBot, a mobile-based medical consultation platform that is widely used in China, and it utilizes state-of-the-art AI techniques. The patients can interact with the chatbot either with text or voice messages. The chatbot provides different services to the users, where self-diagnosis is the most popular feature. The patient describes their symptoms, and the chatbot asks questions related to the symptom. *Fan et al.* (2021) highlight the need for trustworthy health chatbots and focus on user experience and usability.

2.7.2 Prediction of Triage Level

In the field of AI in emergency medicine, research has been devoted to utilizing data from triage assessments to either predict the triage level/score or anticipate clinical outcomes.

Choi et al. (2019) developed a machine learning algorithm to predict the Korean Triage and Acuity Scale (KTAS) outcomes. The KTAS is a commonly used triage tool in Korea. The model presented in the paper was trained using a combination of structured data, such as demographic information (age and gender) and vital signs, as well as unstructured data in free text. The result of the study indicates that machine learning algorithms can predict KTAS levels robustly during triage. Additionally, the use of the nursing triage text data improved the prediction performance compared to only using structured data. *Raita et al.* (2019) used machine learning methods to predict clinical outcomes, including critical care and hospitalization outcomes. These models aimed to minimize the number of critically ill patients who were under-triaged and to reduce over-triaging hospitalization outcomes.

Marchiori et al. (2020) developed a telemedicine triage tool known as the Artificial Intelligence Triage Engine (AITE), accessible to patients via a mobile application. The system aims to assist patients in identifying the most appropriate point of care. To accurately recommend the most appropriate point of care, a thorough exploration of the patient's symptoms is required. To facilitate this process, the application incorporates a Q&A phase, to collect relevant symptoms. The user inputs their symptoms, and a question-generation algorithm is used to guide the interaction further. The questions asked are designed to be concise, and the system allows the user to describe their symptoms in a natural way. Once the symptoms have been fully explored, the tool suggests appropriate actions to take, such as scheduling a teleconsultation or visiting a general practitioner.

2.7.3 Speech to Text

Although the primary responsibility of physicians and clinicians is to care for their patients, they also need to document and consult clinical data (*Joukes et al.*, 2018). Clinical documentation is, therefore, an important and time-consuming task the clinicians must balance with their patient encounters. One potential tactic for the clinician is to document while conversing with the patient, but this could potentially result in the patient not feeling cared for or the center of attention (*Lee et al.*, 2016). On the other hand, documenting after an encounter can lead to the loss of important information.

Ideally, clinical documentation would be an automated process with minimal input from humans. Automatic speech recognition and natural language processing techniques have the potential to automate clinical documentation with clinical scribes (*van Buchem et al.*, 2021). Over the past few years, there has been an increase in the use of speech recognition technology by clinicians for clinical documentation (*Blackley et al.*, 2019). A digital scribe is an automated clinical documentation system that generates documentation of the clinical encounter based on the clinician-patient conversation (*Quiroz et al.*, 2019). This could potentially reduce the need to split the attention between the patient and documentation and could result in a more patient-centered encounter. According to *Quiroz et al.* (2019) there are three main tasks that are included in the process of automating clinical documentation. These are: 1) recording the patient-clinician conversation, 2) converting the audio into text, and 3) extracting the most important information and summarizing.

2.8 Human-Computer Interaction

In the early 1980s computers underwent a significant transformation as they transitioned from laboratory settings to use in offices and homes. During this period, computers evolved from being large systems housed in restrictive rooms and used by technical individuals, to personal computers found on desktops. This shift opened the use of computers to a broader audience of non-technical users. Consequently, ensuring ease of use became a crucial concern to prevent product failure, and the need for human-computer interaction (HCI) became important to ensure that these systems also were usable for less experienced users (*Lazar et al.*, 2017, p. 2). While HCI initially was concerned with computers, it has expanded to cover almost all forms of information technology design.

HCI draws on many different disciplines including computer science, cognitive science, human factor engineering, and other related fields (*Lazar et al.*, 2017, p. 2). The main objective of HCI research is to enhance the interaction between humans and computers by creating interfaces that are intuitive, efficient, and satisfying for users. To do so, researchers aim to understand user needs, abilities, and preferences, and seek to design to accommodate these factors.

2.9 Human-AI Collaboration

Similar to how computers transitioned from being used primarily in laboratories to being adopted by non-technical users in offices and homes, artificial intelligence is now moving from research labs to real-world applications (*Wang et al.*, 2020). The performance of AI systems has rapidly improved to match or exceed human experts. However, fully autonomous AI systems remain disruptive, dangerous, and unethical in high-stake contexts (*Lee et al.*, 2021). As a result, the need of involving humans to interact with AI systems has received increasing attention and has led to the rise of human-AI collaboration. Human-AI collaboration refers to the collaboration between single or multiple humans and AI systems (*Lai et al.*, 2021). It recognizes that both AI and humans have unique capabilities that have the potential to complement each other's strengths to achieve better outcomes. Building upon this understanding, Human-AI collaboration focuses on how to augment human work and extend human cognition.

A considerable amount of literature in the field of Artificial Intelligence studies the performance of AI-based medical devices or the improvement of diagnostic accuracy when supported by AI. However, *Reverberi et al.* (2022) addresses that our understanding of the context, design, and psychological mechanisms necessary for creating an ideal human-AI collaboration is currently limited.

Different challenges and pitfalls have been proposed when facilitating a successful Human-AI collaboration and interaction. *Reverberi et al.* (2022) proposed three pitfalls to avoid when building an effective human-AI team. These are over-reliance, under-reliance, and opacity of judgments´ reliability. Over-reliance refers to when the users adhere to whatever option or suggestions offered by the AI and therefore ignore their independent evaluation. Under-reliance is when the user ignores the suggestions provided by the AI, even in cases where it could be helpful or important information that should be considered. The last pitfall presented entails that it can be challenging to determine the reliability or accuracy of a particular judgment. This can make the users unable to determine whether the opinions or decisions generated by the AI are more or less reliable than their own decisions. Another hindrance to human-AI collaboration is the lack of interpretability and transparency these models hold, so-called "black boxes" (*Lai et al.*, 2021).

2.10 Chapter Summary

Triage refers to the process by which healthcare providers categorize patients by the level of emergency so that those in most need of treatment will be assisted first. In Norway, citizens can contact the OOH service by phone and receive assistance for their medical concerns. The calls are handled by registered nurses who follow a triage system to determine the urgency and appropriate course of action for each caller. This can be a demanding process due to the high volume of calls and the need for quick decision-making. The nurses have to navigate through the support tools and document the encounter while simultaneously engaging in a natural conversation with the caller.

Clinical decision support systems and symptom checkers can be utilized as an aid for the assessment. While symptom checkers are created for the patients, they seek to resemble clinical decision support systems created for health professionals. These tools can improve consistency and support the users in making more informed decisions. However, these tools can impose unfortunate effects when being too rigid. Healthcare professionals prefer to write their documentation in free text. The benefit of this method is that it could be easier to capture and describe complex situations. However, free text documentation makes interpretation difficult for computers and makes it hard to provide real-time clinical decision support. Autocompletion and post-recognition have been proposed as a strategy to create semi-structured documentation from free-text documentation.

The emergence of artificial intelligence has led to the development of innovative techniques and technologies to enhance various tasks in healthcare, with the potential to augment and amplify human intelligence. However, in order to fully realize their benefits, it is essential to facilitate human-AI collaboration. While extensive research focuses on the accuracy and performance of AI technology in healthcare, there is limited research addressing the context, design, and psychological mechanisms required for creating an ideal human-AI collaboration. Over-reliance, under-reliance, and opacity of judgments´ reliability have been proposed as pitfalls when creating systems for human-AI collaboration.

Chapter 3

Methodology

The research questions *(as introduced in Chapter 1)* for this study are:

R1: *How can we design for supporting telephone triage with AI-based suggestions and semi-structured documentation?*

R2: *How can a triage tool facilitate the use of natural language in the process of creating semi-structured documentation?*

This chapter presents an overview of the research methodology and methods applied in this study. Research through design was used as an overarching approach to the research. To answer the research questions, it was important to include users in the prototype development. This was done by evaluating the prototypes using design critique and interviews, and walkthroughs with participants. The chapter will also present the methods used when designing the prototype as well as the methods used for evaluation.

3.1 Research through Design

Research through Design (RtD) is an approach to conducting research that employs methods, practices, and processes of design practice with the intention of generating new knowledge. This approach allows for an exploratory process, by acknowledging the development of an artifact as a source of knowledge and contribution to research (*Zimmerman et al.*, 2007). Researchers can generate new knowledge by understanding the current state and then suggesting an improved future state in the form of design. As this project aims to conduct research and gain insights by creating an artifact to support the nurses during triage, the RtD approach was considered highly appropriate.

In the context of RtD, "wicked problems" refers to problems that are complex and hard to define. These problems cannot be accurately modeled and addressed using the approaches of science and engineering (*Zimmerman et al.*, 2007). They are characterized by their complexity, ambiguity, and the absence of straightforward solutions. RtD engages with wicked problems by embracing their complexity and employing design methods to explore potential solutions. The proposed solutions to wicked problems cannot be characterized as true or false, but rather as good or bad based on one's framing of the initial problem (*Rittel and Webber*, 1973). The aim of RtD when dealing with wicked problems is not necessarily to find a definitive solution, but rather to explore possibilities, generate knowledge, and contribute to a better understanding of the problem.

Designing an artifact to support nurses in telephone triage with AI can be seen as a wicked problem due to the absence of definitive or objectively correct solutions. This problem holds value in the RtD process as it offers an opportunity to gain understanding, explore possibilities, and generate new knowledge about the complex process of supporting triage and decision-making.

3.2 Design Methods

This section presents the design methods used in this thesis.

3.2.1 Conceptualize the Workflow

Conceptualization is a well-known technique in HCI and RtD. In the context of HCI and RtD, conceptualization refers to the process of developing a conceptual understanding or model of a system, interface, or design concept. These models can also be used to articulate the problem and design space (*Sharp et al.*, 2019, p. 70-74). While this technique is commonly used to show how the users can interact with the system, this thesis employed conceptualization to gain a deeper understanding of the current workflow. This was done to gain an understanding of the tasks involved in telephone triage by reviewing the relevant literature and insights from the RE-AIMED team. The conceptualization of the workflow was created using flowcharts, see Section 4.1. Despite its simplicity and limited representation of the diverse range of calls and conversations, this model proved to be valuable for both developing the model itself and guiding the design process. However, it is also recognized that it would be beneficial to also create a model visualizing how the prototype was intended to support the tasks.

3.2.2 Establishing Requirements

Discovering requirements focuses on exploring the problem space and defining what will be developed (*Sharp et al.*, 2019, p. 385). It involves understanding the users and their capabilities, what to support, and user tasks and goals. Requirements can be established through targeted activities, evaluation, prototyping, design, and construction. The discovery and formulation of requirements is an iterative process to ensure that the findings from the steps in the design process are considered further in the process. A requirement is a statement that describes what a product is supposed to do and how it will work (*Sharp et al.*, 2019, p. 387). Requirements are traditionally divided into two types, functional and non-functional requirements (*Sharp et al.*, 2019, p. 390). The functional requirement describes what the product will do. While non-functional requirements entail the characteristics of the product.

The first set of requirements was established in the first phase of the design process. These requirements were derived from a combination of challenges identified in the literature and the perceived limitations of the existing RE-AIMED prototype. As the design process progressed, the requirements were updated after evaluation of the prototype. The process of establishing requirements was valuable as it transformed the insights and feedback into concrete aspects or functions the prototype should entail supporting the triage process. It also made it easier to keep track of the changes in the prototype.

3.2.3 Prototyping

Prototypes were used in this project to visualize ideas and to gather feedback. *Sharp et al.* (2019) defines prototypes as *"one manifestation of a design that allows stakeholders to interact with and explore its suitability"*. Utilizing prototypes can enable the communication of design ideas and be used when evaluating. However, as highlighted by *Lim et al.* (2008), using prototypes as a means for evaluation is a relatively small part of the entire design process. Prototypes also serve as a means for designers to learn, discover, generate, and refine designs. They are deeply integrated into design thinking and are not merely tools for evaluating or determining the success or failure of design outcomes.

Prototypes can take many forms, from low-fidelity paper-based sketches to high-fidelity complex systems. Low-fidelity prototypes are a representation of the design in a simple form, it will not look like the final product, nor have the same functionality (*Sharp et al.*, 2019, p. 426). However, they can be useful because they are simple, cheap, and fast to produce, and thus an easy way to explore and communicate initial ideas. A high-fidelity prototype looks more like the finished product and can provide functionality close to the final product (*Sharp et al.*, 2019, p. 428).

The first prototype made in this study was a low-fidelity prototype drawn on paper. As the design process progressed, the prototypes were created using a digital prototyping tool. Figma (*Figma Inc.*) was used to design the mid-fidelity and the two high-fidelity prototypes. The mid-fidelity prototype was not interactive but was used to display the design ideas to get feedback from the RE-AIMED team. The first high-fidelity prototype was made semi-interactive. This was done to display the prototype to real users and to allow them to interact with the prototype to understand better how it could work. The process of making the prototype semi-interactive was time-consuming, as it aims to be flexible and includes many actions in each step. For this reason, it was decided not to make the last prototype as interactive as the previous one but rather focus on implementing the requirements that were established for the users. The feedback received from showcasing the prototypes to both the RE-AIMED team and the participants was highly valuable. It not only helped to establish requirements for improving subsequent prototypes but also provided new perspectives and ideas for the current design.

3.3 Evaluation Methods

Evaluation plays a crucial role in the design process. It involves collecting and analyzing data about users' experiences when interacting with a prototype (*Sharp et al.*, 2019,

p. 496). This thesis used evaluations as a means to further improve the design of the prototype. The following sections describe the evaluation methods that have been used throughout this project.

3.3.1 Heuristic Evaluation

Heuristic evaluation is a technique used to identify usability issues in a user interface design and can be used as a part of an iterative design process (*Nielsen*, 1995). In a heuristic evaluation, the researcher uses ten general principles, referred to as heuristics, *(Appendix C Heuristics)*. These principles are not directly usability guidelines but are meant to serve as rules of thumb (*Nielsen*, 2005). They seek to resemble high-level design principles such as reducing memory load, using terms the user understands, and making designs consistent.

This type of evaluation can be used when it's not practical to involve users, because they are unavailable or difficult to find (*Sharp et al.*, 2019, p. 550). It can be used to discover usability or potential usability issues early in the design process. To conduct this form of evaluation it is suggested that 3-5 persons should perform the heuristics to identify as many of the problems as possible (*Sharp et al.*, 2019, p. 552). However, this method was used in this thesis and performed by the writer alone. While this is not sufficient to identify all usability issues, it was used as a basis to identify some of the potential issues of the existing system. Therefore, the findings from this evaluation of the RE-AIMED prototype served as guidelines to improve some of the design choices in the new prototype. The evaluation technique was not applied to the prototypes developed in this project. However, it is acknowledged that conducting this evaluation technique on the created prototypes would be an advantage. It is recommended that other researchers or potential users perform this evaluation to gain valuable insights.

3.3.2 Design Critique

Design critique is a method to collect feedback from stakeholders and experts. It involves using constructive criticism to gather feedback on a design at any stage of the prototype or project's lifespan to determine whether it is meeting its objectives or not and to improve the design (*Alabood et al.*, 2022).

Based on the aim of this thesis and using the research project RE-AIMED as a starting point, it was considered appropriate to use their clinical expertise to obtain feedback on the design for possible improvements. The design critique session involved a presentation of the prototype and an explanation of the design goals and intentions. It provided a discussion and feedback based on the design, as well as suggestions for improvement. The insights gained from one of these sessions are presented in Section 5.1.1. Although only the findings from one design critique session were presented, several informal discussions about the design, challenges, and solutions were held during the regular meetings with the RE-AIMED team. These served to guide and make smaller changes between the four iterations.

3.3.3 User Study

To better understand how we could support telephone triage, telephone operators were invited to evaluate the prototype. This session consisted of three sections, a semi-structured interview, testing the system, and lastly, a post-test semi-structured interview.

Semi-Structured Interviews

One can think of interviews as a "conversation with a purpose" (*Sharp et al.*, 2019, p. 268). Researchers in the HCI community utilize interviews to better understand the needs, practices, concerns, and preferences of individuals who may engage with a current or future computer system (*Lazar et al.*, 2017). Interviews are commonly categorized into four main types, which include unstructured, structured, semi-structured, and group interviews or focus groups. The first three types of interviews are named according to the degree of control the interviewer has over the conversation by following a predefined set of questions often referred to as an interview guide. A semi-structured interview was seen as the most appropriate form of interview in this setting. This is because it allows for a certain degree of flexibility in the interview process.

A semi-structured interview was used in this thesis both before and post-testing of the prototype. This was done to understand the challenges the nurses currently experience in their workflow. Both in terms of their technical tools and general challenges during triage, such as the interaction between the caller and operator. It was also used to get any additional feedback from using the prototype, potential improvements, and if they found something challenging.

Walkthrough

When evaluating the prototype with users, it was intended to let the participants use the prototype in a setting similar to telephone triage. It was therefore created two scenarios that represented two different callers and reasons for calling. The participants were encouraged to take their professional role as operators while the writer was the caller. However, since the system was only semi-interactive, the two scenarios also guided the participants through the system. The participants were guided through various design features, functionalities, and interactions.

This type of evaluating the prototype follows what *Lazar et al.* (2017) characterizes as formative usability testing. Formative usability testing is often informal, with communication between the moderator and the participant. It focuses more on how the user perceives an interface rather than measuring how well a user completes a task. The participants were encouraged to use the "think aloud" method by voicing their thoughts, concerns, and suggestions while interacting with the prototype.

This approach was deemed appropriate as it allowed the participants to envision and engage with the prototype in a way that reflected its potential use in a real-world setting.

Reqruiting Participants

The study included nurses that work as telephone operators in the OOH service. The participants were recruited by contacting the LEMC, where the nurses were asked if they wanted to participate. Participants received a gift certificate of 500 NOK for their participation. The inclusion criteria for the participants were (1) currently working as a telephone operator in the LEMC or having this experience and (2) being able to attend physically.

3.4 Data Analysis

The resulting data from the interviews and usability testing were qualitative, in the form of audio recordings that were later transcribed. A qualitative analysis aims to turn unstructured data found in the text and other artifacts into a detailed description of the important aspects of the situation or problem under consideration *Lazar et al.* (2017). To analyze the data, a thematic analysis was used. The reason for selecting this method was because of its accessibility and flexibility. Additionally, it is a method recommended and well-suited for people new to qualitative research.

Thematic analysis is a technique that involves systematically identifying, organizing, and offering insights into patterns of meanings *(themes)* across a dataset (*Lazar et al.*, 2017). It allows the researcher to see and make sense of shared meanings and experiences in the data. *Braun and Clarke* (2012) suggest six-step to follow to perform a thematic analysis. These are (1) familiarizing yourself with the data, (2) Generating initial codes, (3) Searching for themes, (4) reviewing potential themes, (5) defining and naming themes, and (6) producing the report.

A common technique for exploring data, identifying themes, and getting an overview of the data is to create an affinity diagram *Sharp et al.* (2019). This approach seeks to organize insights into a hierarchy and reveals shared patterns and themes.

Unlike quantitative methods, qualitative methods do not aim to eliminate subjectivity. It requires the researcher to make a series of decisions regarding the interpretation of individual observation, and this can result in some unconscious biases (*Lazar et al.*, 2017). However, qualitative data can provide a deeper understanding and insights into problems compared to quantitative data.

To analyze the data collected from the interviews and evaluation with telephone operators, a thematic analysis approach was utilized. The first step involved transcribing the recorded interviews. Once all the interviews were transcribed, a review of the transcriptions was conducted to develop an overall understanding of the data. Following that, each transcription was revisited, and codes were generated based on the identified patterns and concepts within the data. The coding process involved assigning labels to specific segments of the transcriptions. After the transcriptions were coded, the next step involved organizing the codes into different themes. To facilitate this process, an online platform called Miro (*Miro Inc.*) was used to sort and group the codes. By employing this approach, it became easier to get an overview of the data as well as to identify themes from the interviews.

3.5 Chapter Summary

This chapter provided an overview of the framework used in this thesis, namely Research through Design (RtD), and outlined the methods employed in both the design and evaluation phases. Table 3.1 shows an overview of the different stages in the process of developing the prototype.

Iterations	Define/redefine	Fidelity	Data	Evaluation
1.	Define	Low	Literature review and insights from RE-AIMED	N/A
2.	Redefine	Med	Result from heuristic evaluation of RE-AIMED prototype	Design critique
3.	Redefine	High	Insights from workshops held by RE-AIMED, and findings from design critique	Evaluation with telephone operators
4.	Redefine	High	Insights and results from interviews and evaluation with telephone operators	N/A

Table 3.1: Overview of the phases in the design process

Chapter 4

Requirements and Initial Ideas

This chapter aims to present the tools used in the design process and the two initial phases of the design process. These consisted of a conceptualization of the workflow of the telephone operators based on the literature and insights from RE-AIMED, the first set of requirements, initial sketches, evaluation of the RE-AIMED prototype, and low-fidelity prototype.

4.1 Tools

Different tools were used throughout this project.

Figma is a web-based vector graphics editor and prototyping tool (*Figma Inc.*). It offers a variety of design tools and design kits that can simplify the design process. Figma was used to explore different design variations and when making the prototype, both low-fidelity and interactive prototypes.

Lucidchart is a web-based diagramming application that allows users to make charts and diagrams (*Lucid*). The application was used in this project to make diagrams to visualize the workflow of the telephone operators.

Miro was used to get an overview of the feedback from the user evaluation (*Miro Inc.*). It was originally an online collaborative whiteboard platform. It was used in this project in the process of analyzing the feedback using thematic analysis.

4.2 Phase One: Initial Ideas and Definition

In the initial phase of the design process, the focus was on understanding the domain and defining the project scope and goal. This involved gaining insights into the nurse's workflow through literature and meetings with the RE-AIMED team. Time was also spent on understanding the functionality and intended purpose of the prototype proposed by the project.

4.2.1 Understanding the Workflow

Through the meetings with the RE-AIMED team, the researchers explained what a typical conversation might look like for the telephone operators in the LEMC.

When a patient contacts the LEMC, the conversation typically begins with the telephone operator introducing themselves and the name of the LEMC. The nurse's goal is to first gather personal information such as the patient´s name, personal identification, and current location. This is to ensure that the patient has reached the correct LEMC depending on their location and to have adequate information in the case of an urgent need for assistance. However, some patients may immediately present their problem or reason for calling, thus deviating from the conversation template. The telephone operators must therefore decide whether to interrupt the patient to collect personal information or let them continue, particularly if the situation sounds like an emergency. Both strategies have their challenges. Obtaining the patient's name and location is essential for the nurse to access the patient's medical history at the emergency center and link the documentation to the correct individual. Contrarily, interrupting the patient may cause them to lose their train of thought and forget crucial information.

Once the personal information and the initial problem are presented, the nurses have to decide whether this is an emergency, or whether they have time to further explore the caller's symptoms. If it's not an immediate emergency, the nurses select the corresponding chapter in their decision support tools such as the NINM and Manchester Triage. The nurses are working their way from the highest urgency level and down. This is to ensure that the most urgent situations are ruled out first. In the chapters in the support systems, there are discriminators. These provide an explanation of the characteristics that will result in the given triage level. Additionally, these discriminators are used to document and explain why the triage level was selected. Some nurses write the documentation during the conversation, while others write keywords and complete the documentation after the conversation.

4.2.2 Conceptualizing the Workflow

Based on the information gained through RE-AIMED and the relevant literature on the phases of telephone triage, a model was created aiming to illustrate the steps the nurses do when performing telephone triage, see Figure 4.1. While not visible in the model, the nurses have to document the encounter simultaneously.

4.2.3 RE-AIMED

As a starting point to investigate how AI can assist the nurses during triage, time was spent exploring and understanding the RE-AIMED prototype. Insights were gained through the regular meetings where the researchers explained its functionality and purpose. Access to the prototype was also given to further explore how it could be used.

The prototype leverages machine learning to aid the nurses during triage. Therefore, exploring a new approach to assist the nurses compared to the decision support systems

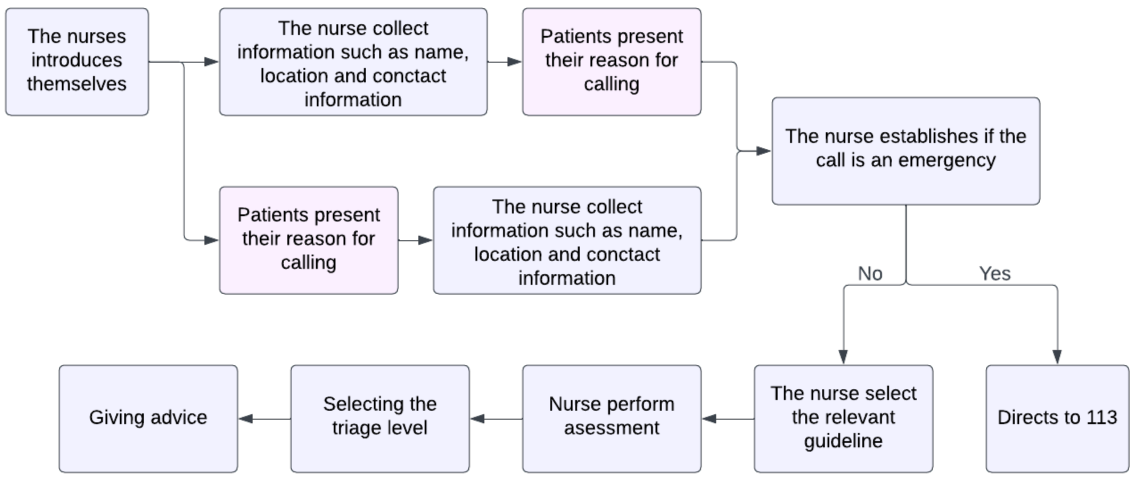

Figure 4.1: A conceptualization of the nurse's workflow in telephone triage

used in Norway today. It suggests symptoms or questions to the nurse to help collect important and relevant information from the caller. At its current state, the system will not suggest the triage level. However, it will inform the nurses if the documented symptoms either correspond to or have the potential to become a red triage level (the highest triage level).

The system relies on an ontology-based approach, using a formal representation of symptoms and questions. This allows for real-time support and structural documentation of the patient's symptoms. The symptoms are organized hierarchically with 13 main categories. The documentation differs from the traditional way, where the nurses document in free text. In the prototype, the documentation is made by confirming or disconfirming the symptoms either from a search or from the suggested symptoms. Some symptoms also allow the nurses to select from alternatives or write a description in free text.

The prototype consists of three main elements, a search bar, a list of suggestions, and documentation. The actual decision support system is mostly a single-page application, besides a window that appears when selecting the location of a symptom. The search bar has multiple purposes. When inactive it can be used to navigate through the main branches and to search for a symptom. In addition, a more detailed list of descriptive questions for a given symptom will be shown here. The list of suggestions consists of 8 symptoms that are continuously updated when symptoms are either confirmed or denied. Both in the suggestion list and the search results, users are provided with two icons (arrows) to navigate up and down the symptom hierarchy. In the documentation, the users can fill in personal information about the patient such as age and gender. Together with the symptoms that have been documented, these will also affect which symptoms are suggested.

The documented symptoms are structured according to their categories. The confirmed and disconfirmed symptoms are differentiated in the way that the denied symptoms have *"Disconfirmed"* (*"Avkreftet"*) as a prefix. The documentation lists all the confirmed and disconfirmed symptoms vertically. The prototype also provides a different visualization of the documented symptom. The users can use a button “copy” that transforms the listed symptoms into a nurse-like written note.

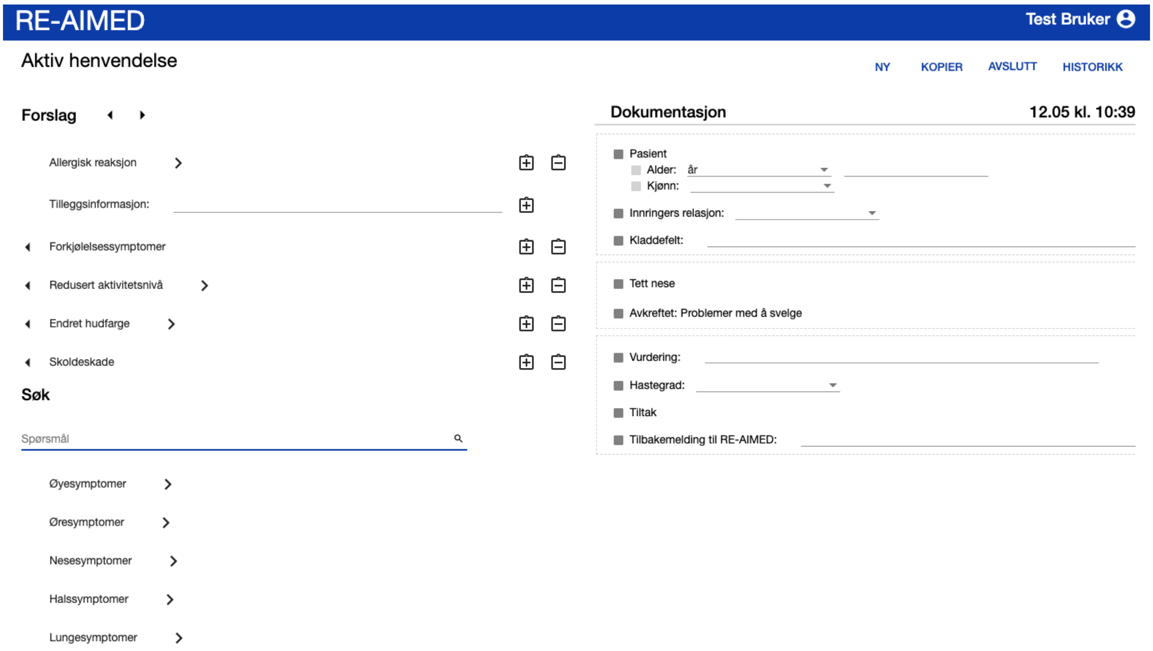

Figure 4.2: RE-AIMED prototype

4.2.4 First Set of Requirements

There are some challenges with using CDSSs presented in the literature. While these tools are made to ensure consistency between the telephone operators when reaching a decision, nurses can feel that their clinical competence is sidelined when following rigid systems. RE-AIMED aimed to solve this by not forcing the nurses to select a path to follow but rather using AI to give suggestions based on the documentation. In this way, they propose a strategy that can create structured documentation when the patient answers the questions suggested by the system. However, the system does not facilitate an easy way of documenting symptoms or information initiated by the patient or the telephone operator. This can only be done through search, which can be challenging when having to navigate while listening for information. As a result, this project will focus on how we can design to facilitate documentation of information initiated either by the telephone operator or the caller.

Based on the insights from the initial phase, the first requirements for the prototype were set.

The functional requirements:

- The system should enable users to write in natural language as an aid in the process.
- The system should enable users to easily write down patient-initiated information.

- The system should support users in all steps of the workflow, not only the assessment.

The non-functional requirements:

- The interface design should be simple and well-structured.
- The system should be flexible in accommodating different user needs and preferences.

4.2.5 Initial Sketches

Based on the requirements, the initial sketches were made. An overview of the prototype's primary components was developed as a starting point, see Figure 4.3. The elements such as the list of suggestions, search bar, and documentation, are intended to work similarly as in the RE-AIMED prototype. In addition, a free-text field was also incorporated. This was intended to allow the nurses to write down what the patients have said or to write keywords to make the process of selecting symptoms easier. Especially if the patient presents so much information that the nurses do not have time to use the suggestions or search.

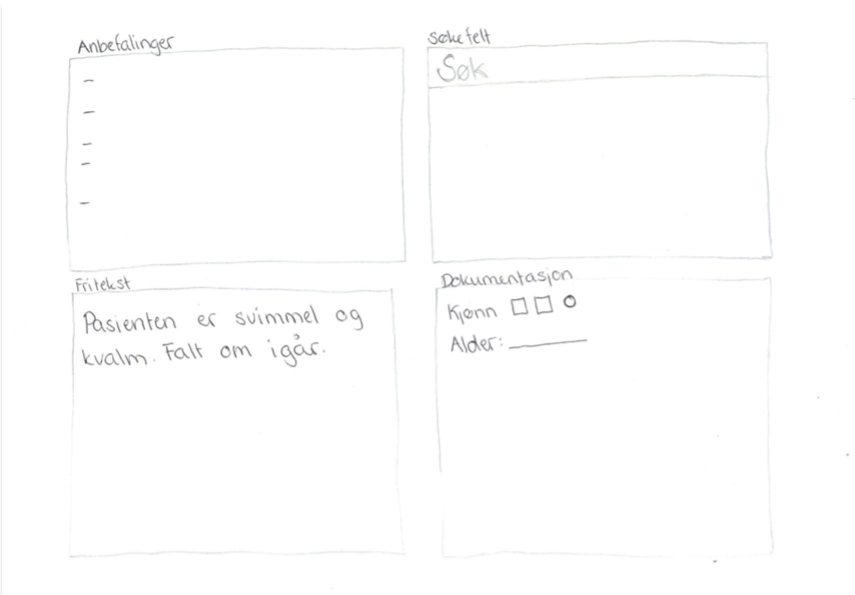

Figure 4.3: The main elements to include in the prototype.

With the creation of the prototype, the goal was to implement a more linear design to facilitate the nurse's workflow. In the figure below, Figure 4.4, the first step in the prototype will be the collection of personal information as well as the initial presentation of the patient's problem. This allows the nurses to have a placeholder if the patient starts to present the chief complaint before introducing themselves. To continue the process, the user can navigate to the next step, which will be the assessment of the symptoms. The written notes from the previous step will be visible in the second step and will serve as an aid to remember what was said initially. Figure 4.4 also illustrated how one could add the location of the symptoms as well as give further description of the symptoms.

Figure 4.5 shows a more detailed vision for the first step. It has a placeholder for name, personal id number, and a field where the nurse can type in free text. Based on the written text in the note, the system can give some suggestions. For example, if fever is written, it can suggest fever. Similarly, like the suggestions from RE-AIMED, the symptoms can either be confirmed or disconfirmed.

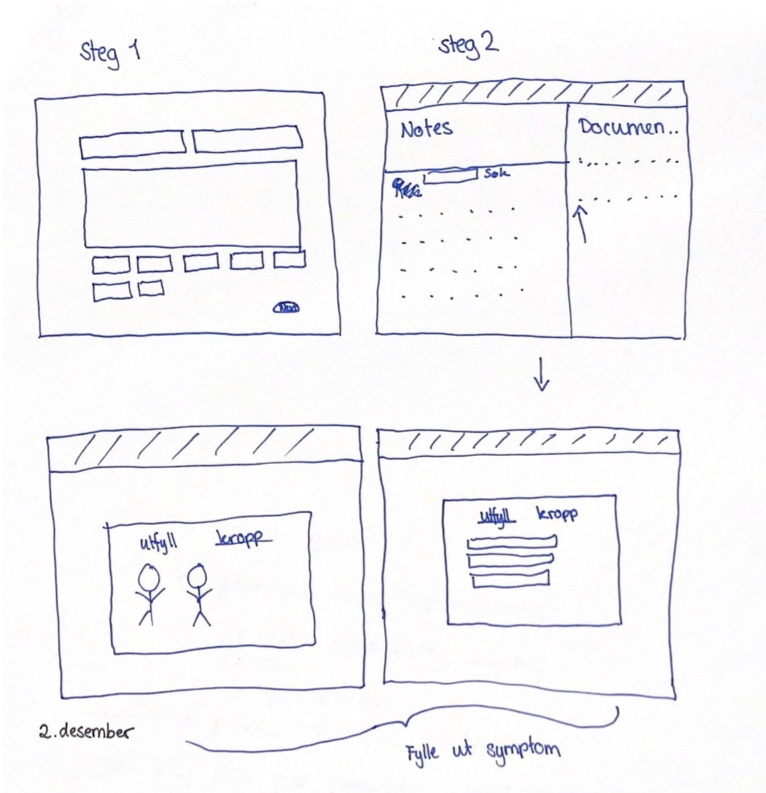

Figure 4.4: The initial plan of how the system flow

The first plan for the note field was to aid the nurses in the first phase of the triage. While creating the initial sketches, it was decided to continue displaying the note field in the following phases. The thought was that the note field could serve another purpose, namely to enable quick search from the note field. A quick search could be performed by, for example, clicking “pain”, and search results would be displayed below the search bar, see Figure 4.6.

4.2.6 Summary

The first phase of the project resulted in a defined project scope and initial requirements and sketches. The prototype is designed as a web application and uses the suggestions and terminology from the RE-AIMED prototype. The interface aims to provide flexibility to the users and provide support at each step. Additionally, the interface should be flexible and make it easy to enter patient- and operator-initiated information.

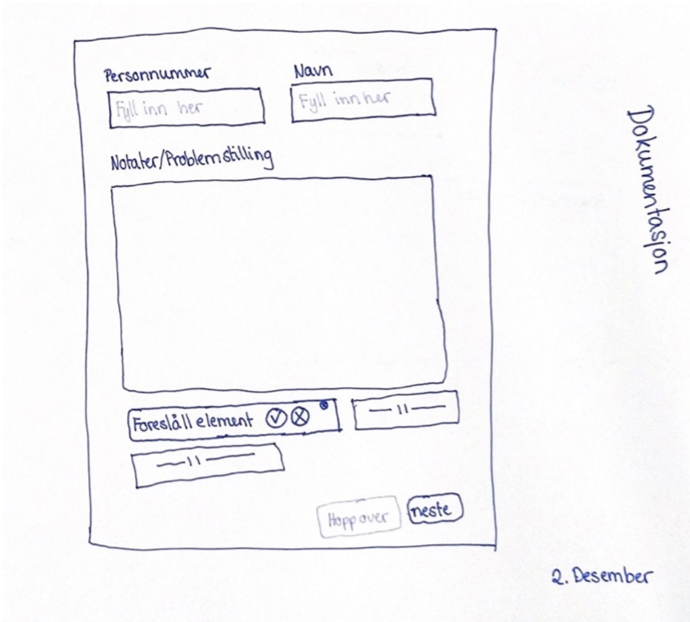

Figure 4.5: Elements in the first step (collection of personal information and chief complaint)

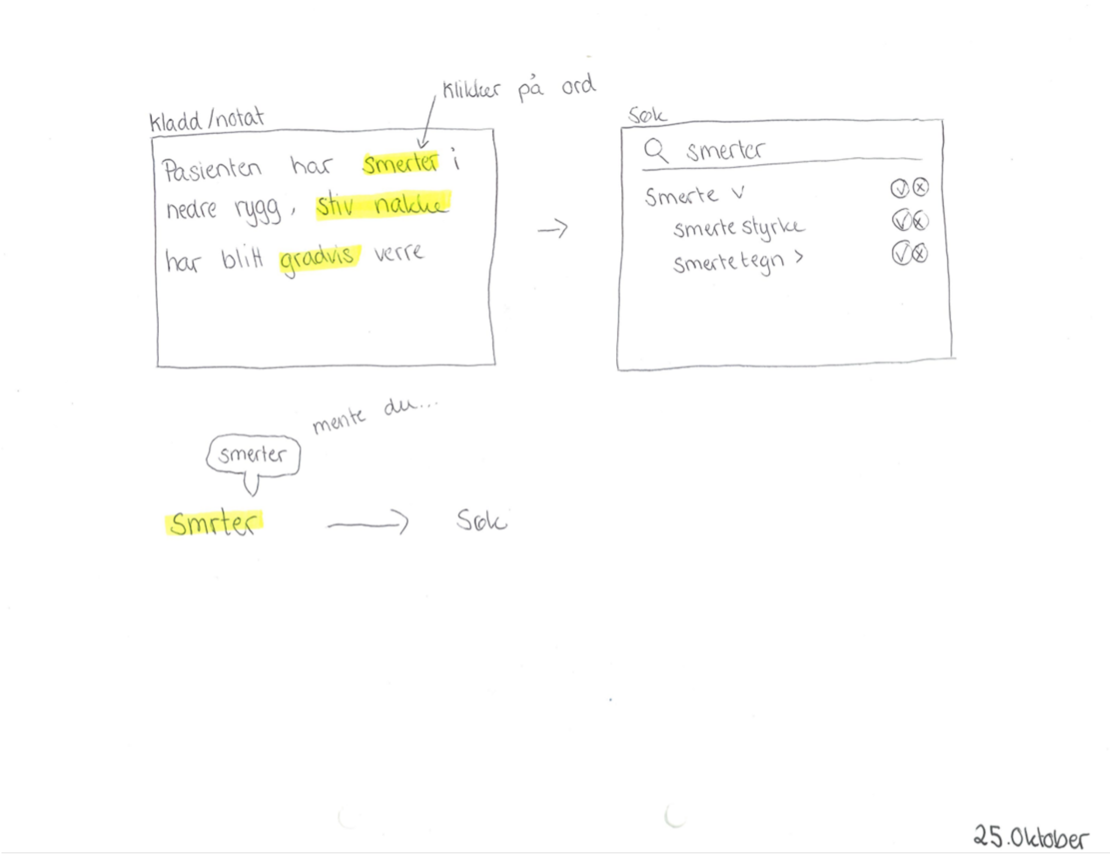

Figure 4.6: Initial sketch of the field to write in free text.

4.3 Phase Two: Evaluating the RE-AIMED Prototype

The second phase of the design process consisted of performing a heuristic evaluation of the RE-AIMED prototype and implementing the prototype from the sketches into Figma.

4.3.1 Heuristic Evaluation

To further get an understanding of potential design implications that can be a hindrance to the usability and user experience of triage tools. An evaluation of the RE-AIMED prototype was done using Nielsen´s heuristics.

1.	Visibility of System Status	- Not showing location when hovering over body parts. - Documented symptoms are not visualized in search results. - Limited feedback on which symptom descriptive symptoms relates to.
2.	Match Between System and the Real World	- Use of icons for confirm and disconfirm - Search field serves multiple purposes
3.	User Control and Freedom	
4.	Consistency and standards	- Different types of icons (arrows) - Pop-up window for location, not for symptom description
5.	Error Prevention	
6.	Recognition Rather than Recall	- Visibility of symptom path
7.	Flexibility and Efficiency of Use	
8.	Aesthetic and Minimal Design	
9.	Help Users Recognize, Diagnose, and Recover from Errors	
10.	Help and documentation	

Table 4.1: The noted issues after performing a heuristic evaluation of the RE-AIMED prototype

No.1. Visibility of System Status

This heuristic suggests that the system should always keep the users informed about what is going on through appropriate feedback within a reasonable amount of time.

The prototype utilizes a body map that is used to select a location of a given symptom. While certain parts of the body map are straightforward to identify, this is not true for all. The prototype allows the users to see the textual representation by selecting the body part. This creates an extra step to see what body part the image represents and does not provide immediate feedback.

As explained previously the user can search for a symptom and from the search results confirm or disconfirm a symptom directly. The symptom can then be seen in the documentation and marked as either confirmed or disconfirmed. However, the elements in the search results do not inform the user that the symptom has already been answered.

Many of the symptoms include a set of additional questions that provide further details about the symptom, such as its duration. If a user confirms a symptom, the system can suggest relevant symptom descriptions. The answered descriptive symptoms are documented below their parent symptom (the symptom they describe). The system offers flexibility in the way that the user can freely decide which symptom the descriptive symptom relates to. To connect a symptom description to a given symptom in the documentation, the user clicks on the symptom in the documentation, and the system provides feedback by darkening the background of the selected symptom. However, the system could be improved by providing feedback to the user regarding where the selected element in the suggestion list will end up in the documentation. Currently, this information is not displayed, which can confuse the user. Additionally, the documentation and suggestion list are placed on opposite sides of the screen, which can require the user to shift their gaze and which could be inconvenient.

To address these issues, the system could display the labels for each body part when the user hovers over it. This would provide the user with immediate feedback about the textual representation of the body part and help to improve the visibility of the system status. The system could also give the user feedback by using an icon that signals that the symptom is answered. For example, if the fever has already been confirmed, the confirm icon could be filled. It could also be possible to inform the user where suggested descriptive symptoms will end up in the documentation.

No.2. Match Between System and Real World

In the prototype, the user can confirm or disconfirm each symptom by clicking on one of two buttons: a plus icon and a negation icon. The symptom will then be added to the documentation as either confirmed or disconfirmed. According to this heuristic, it is beneficial to use icons that are familiar to the user. However, these icons could be associated with adding or reducing a value, for example, in the scenario of a shopping cart. The plus icon signals that we want to add the symptom to the documentation, while the negation may indicate the removal of the symptom, which is not the desired outcome. The use of icons should be carefully chosen to ensure that they are easily recognizable and have a clear meaning. To better signal the actions of confirming or denying a symptom, it may be necessary to consider using different symbols.

The search component in the RE-AIMED prototype serves multiple purposes which can lead to confusion for the user. Perhaps the most intuitive purpose is to search for symptoms and display the results below. However, in the prototype, the component can be used for other tasks. (1) When the search bar is inactive the fields below can be used to navigate through the hierarchy of symptoms. (2) It is used to view the list of descriptive questions and attributes of a documented symptom. (3) The user can also click on a symptom in the documentation to view its associated child symptoms.

This heuristic emphasizes the importance of using concepts and actions that are familiar to the user. In the prototype, the search field serves multiple purposes, which can lead to confusion for the user. This can violate the principle of *"Match Between the System and the Real World"* because the system's behavior may not be consistent with the user's mental model of what a search field should do. Instead, the system should be designed to match the user's mental model and be consistent with their expectations. For example, if the search field is primarily intended to search for symptoms, then it should be clearly labeled as such, and other functionalities should be made explicit through other design elements.

No. 4. Consistency and Standards

To provide more details about a symptom, the users can select description attributes or assign a location to it. To do so, users need to hover over the symptom in the documentation, which reveals two icons: one for descriptive attributes and one for the location. However, while both tasks provide additional information about the symptom, they are handled differently interaction vice by the system. For instance, to assign a location, the user is redirected to a new window to select the body part. On the other hand, descriptive symptoms are shown in the result list. This inconsistency in treatment could confuse users and impact usability. A more consistent design could improve user experience.

No. 6. Recognition Rather Than Recall

The symptoms in the prototype are arranged in a hierarchical order, with certain symptoms dependent on their parent. The user can see the parent symptom by clicking on the arrow on the left side. However, this action opens all the children of the parent and can make it difficult to navigate back to the original symptom. While one can argue that this is designed for nurses that understand the relationship between the symptoms, it imposes an additional cognitive burden. To align with Nielsen's principle of *"Recognition Rather than Recall"* together with better visibility, one could visualize the symptoms path should be more clearly visualized for the user, so it is not necessary to backtrack to see the "parent".

4.3.2 Second Prototype Iteration

The low-fidelity prototype was then implemented in Figma. The findings from the evaluation of the existing prototype served as guidelines on how certain elements and features within the prototype could be improved. The prototype also attempted to reflect the flow of a typical conversation or triage flow. It begins by gathering personal information, followed by exploration of symptoms, and then a summary. The interface of the summary page had not been implemented at this stage. However, the idea was to use this page as a reminder for the nurses to review the free-text field to make sure that everything has been documented structurally. The prototype includes a progress bar in the header that indicates the user's location within the system. Despite being linearly designed, the progress bar offers the user flexibility to navigate back and forth in cases where the caller interaction deviates from the usual flow.

Personal Information and Chief Complaint

Figure 4.7 shows the initial screen when starting the triage process. This screen includes the documentation on the right. In the center of the screen, there is a window to collect information about the caller as well as a free-text field that the nurse can use to write the initial information the caller presents. This field enables the nurse to record the initial information presented by the caller, allowing for flexibility in the system. In cases where the patient presents their problem before providing their personal information, the nurse can use the free-text field to document the information.

This note serves two purposes, it can be used as an aid for the nurses to remember what the caller said initially and to be used by the system to suggest symptoms to be confirmed or disconfirmed, making the documentation structured. These suggestions can be seen below the note. Although the goal is that the system recognizes the symptoms, we don't want to add them to the documentation directly. It is, therefore, an extra step where the nurses can confirm, disconfirm or ignore the suggestion. In this prototype, a checkmark was used as the confirming sign and an x for disconfirm. After filling in this initial information the users can click on the *"continue"* (*"fortsett"*) button to continue to the next page. The users can also skip this step altogether by clicking on the *"skip"* (*"hopp over"*) button.

Exploration of Symptoms

Figure 4.8 shows the screen for symptom exploration. The documentation appears in the same position as in the previous step, while the list of "AI-based" suggestions is centered. The list of symptoms consists of eight suggested symptoms. Each symptom element comprises the text representation for the symptom, its path, and the confirm and disconfirm icons. The path serves a dual purpose: it facilitates navigation up in the hierarchy and provides feedback on which symptom it relates to. Additionally, some symptoms feature a plus icon as a prefix, indicating the presence of symptoms below (the symptom has "children"). Clicking on this icon allows the user to expand and view these associated symptoms.

In the user interface, the hierarchical list view of symptoms is positioned separately from the search field. The search bar is placed below the list of "AI-based "suggestions, while the hierarchical list of symptoms is positioned on the left side of the screen. The initial note written in the first step is placed in the top left corner of the screen, which may seem unconventional at first. However, this placement was chosen to ensure that the note field is easily visible and accessible to the user. This positioning also allows for consistency with the documentation field, which maintains the same location throughout the triage process.

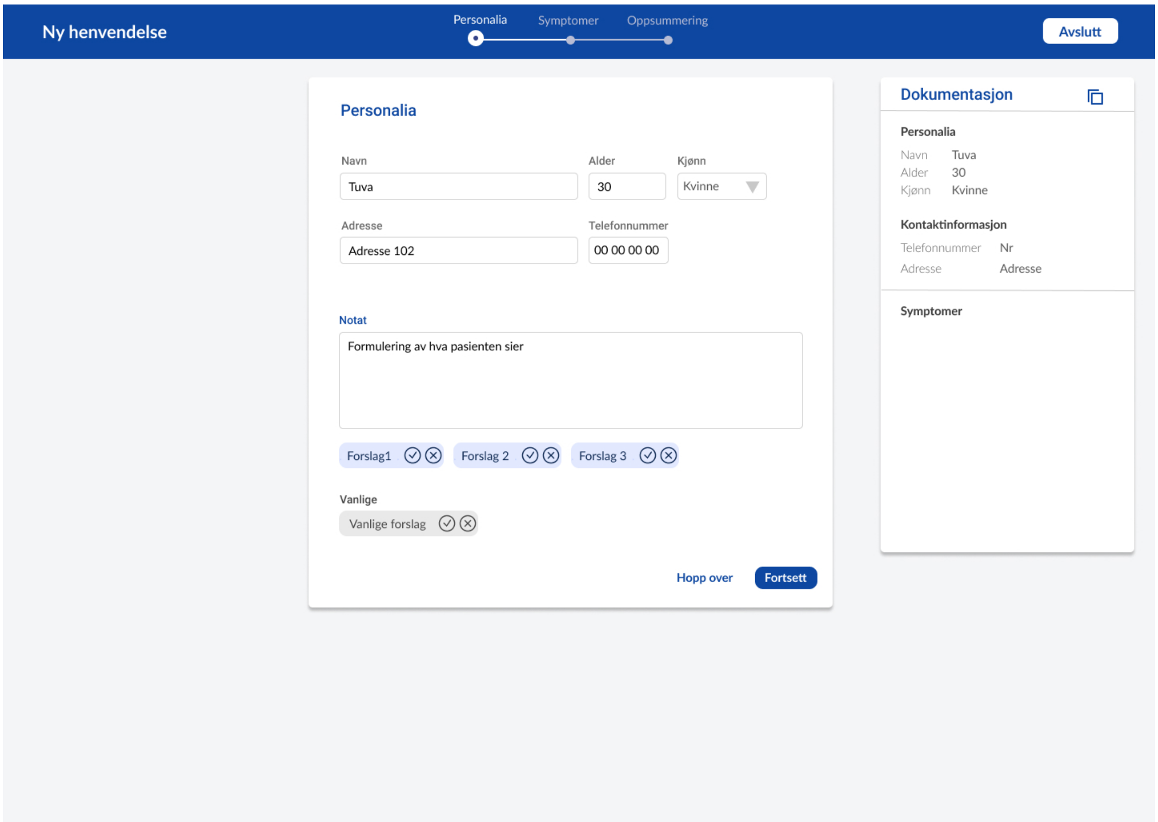

Figure 4.7: Mid-fidelity prototype: the initial collection of information.

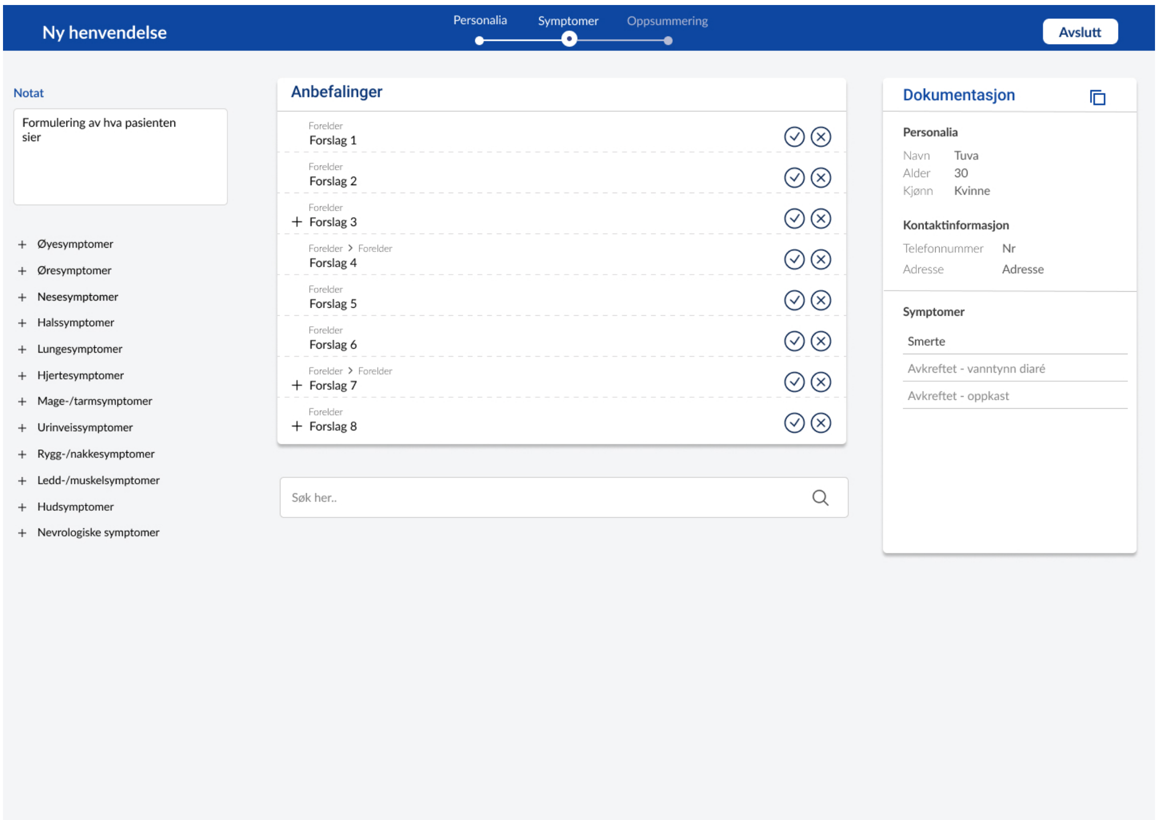

Figure 4.8: Mid-fidelity prototype: the exploration of symptoms.

Symptom Description

To provide a more detailed description of a symptom, the user can click on the "edit" icon next to the symptom in the documentation. This action will open a new window displaying a list of questions related to the symptom, see Figure 4.10. At the top of this window, the user can choose between two options: *"symptom description"* and *"location"*. Selecting the *"location"* option will direct the user to the body map page, see Figure 4.9 .

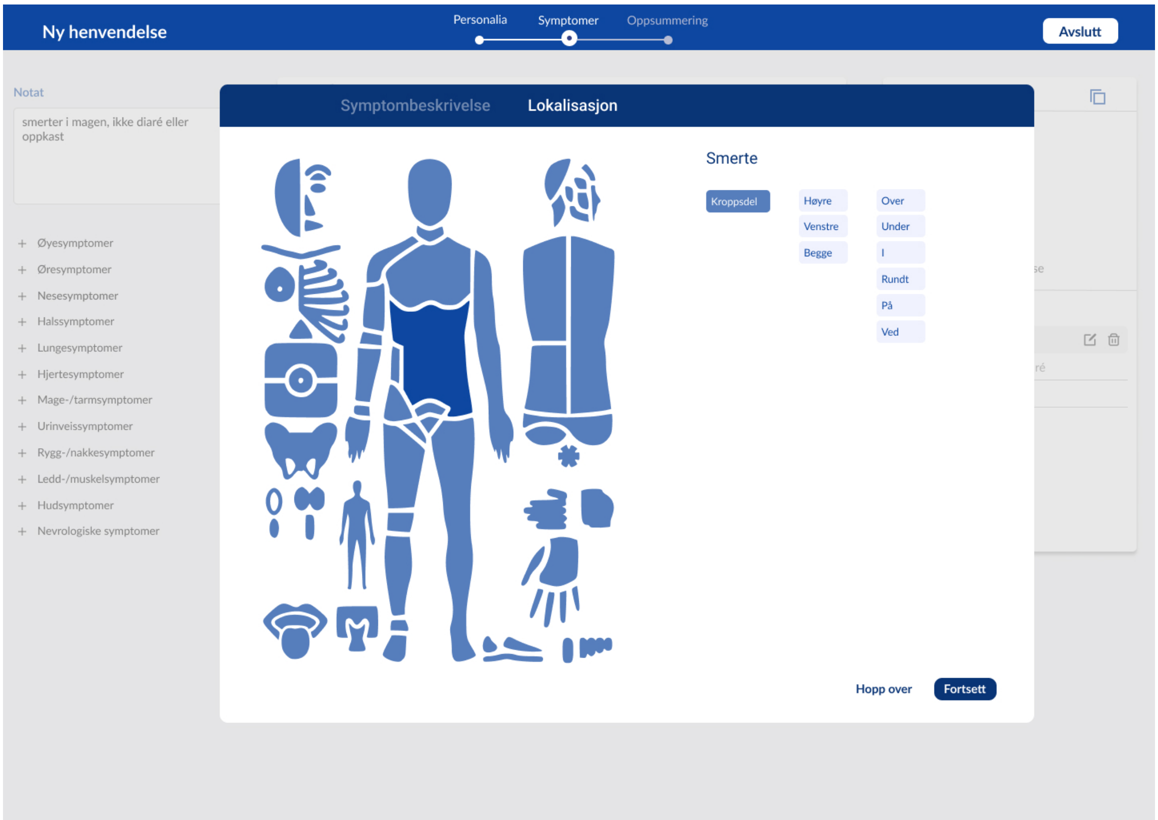

Figure 4.9: Mid-fidelity prototype: localization of the symptom

The symptom description consists of questions of varying types. Some questions allow the user to confirm or disconfirm them, while others present multiple alternatives. To minimize the number of clicks required to select the alternatives, it was decided to display all the available options, and the user can choose the appropriate one by clicking on it.

While providing enough information to the user is important, there is a risk of overwhelming them with too much text. To avoid cluttering the screen, some information or questions are hidden until the user clicks on a specific symptom. For example, if the user confirms the question *"Has the symptom occurred multiple times?" ("Har skjedd flere gang")*, the follow-up alternatives will be displayed, see Figure 4.11.

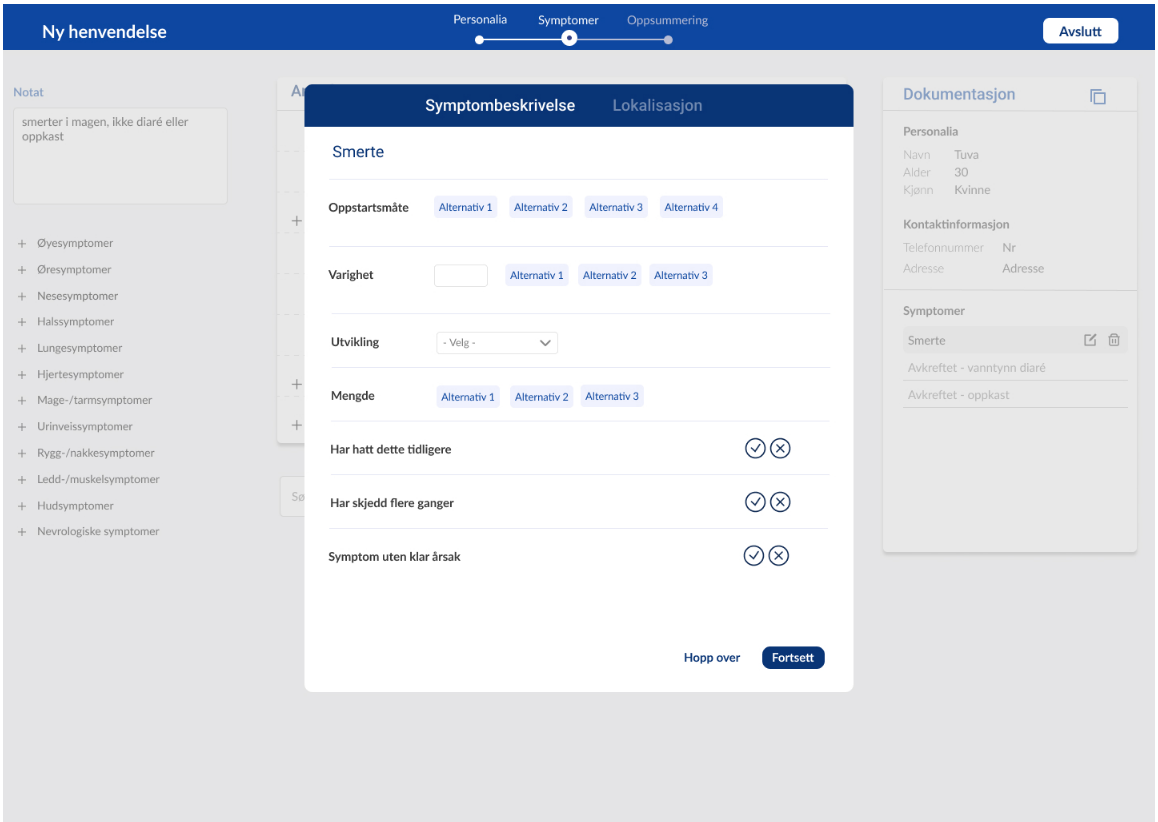

Figure 4.10: Mid-fidelity prototype: symptom description.

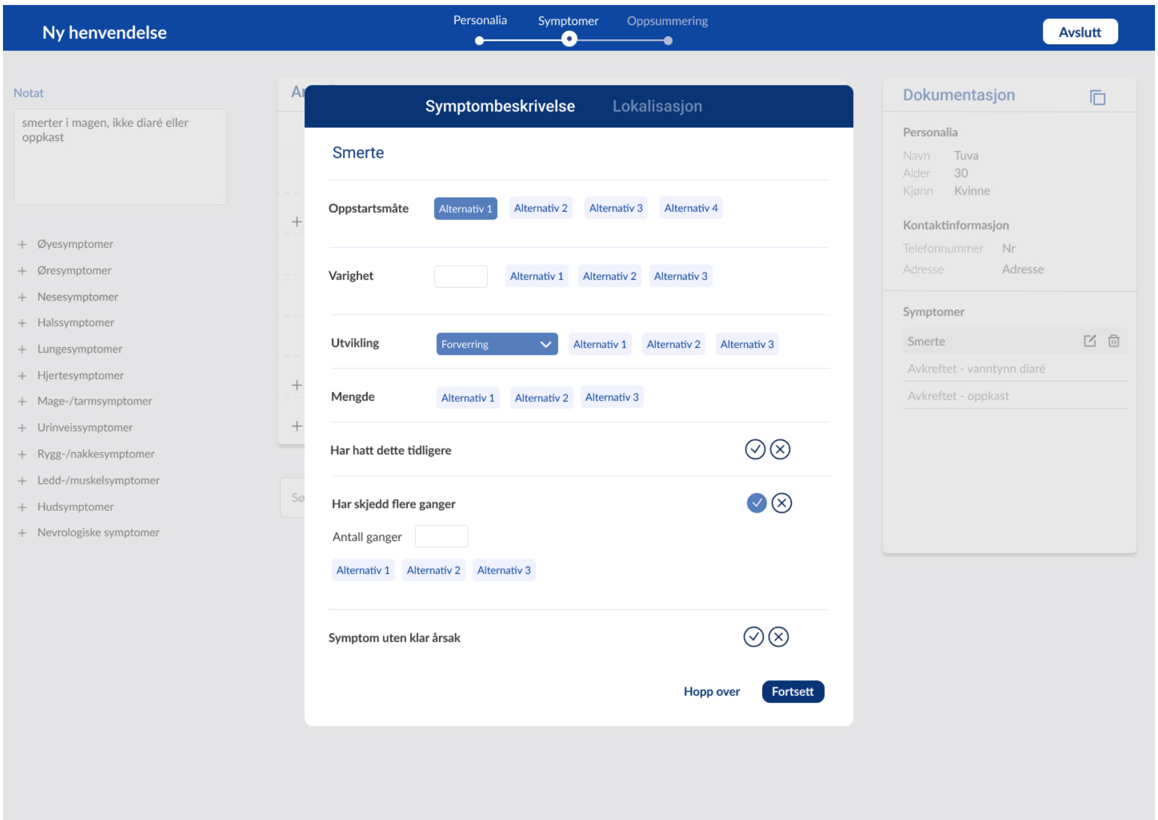

Figure 4.11: Mid-fidelity prototype: symptom description, more information displayed.

4.3.3 Summary

During the second phase of the design process, a heuristic evaluation was employed to identify any shortcomings or violations within the RE-AIMED prototype. While not all the identified elements were incorporated in the prototype at this stage, these findings were useful in the proceeding prototype iterations.

4.4 Chapter Summary

This chapter covered the first two phases of the design process. The initial phase established the project scope, requirements, and the creation of the sketches. In the second phase, a heuristic evaluation was conducted to identify shortcomings of the design in the RE-AIMED prototype, and the initial sketches were implemented in Figma. While not all of the findings from the heuristic evaluation were incorporated into the second prototype, they served as valuable guidance for the ongoing design process.

Chapter 5

Prototyping and Evaluation

This chapter presents the subsequent phases of the design process and evaluation of the prototype. The prototype was first evaluated in a design critique with the RE-AIMED team. This phase also includes insights and findings from a workshop held by one of the researchers in RE-AIMED. Based on these findings, an interactive prototype was created. The prototype was then evaluated by telephone operators.

5.1 Phase Three: Design Critique and Workshop findings

This phase included feedback from the RE-AIMED team and findings from a workshop held by one of the researchers in RE-AIMED. The insights gained from this phase helped to get a better understanding of the user's needs and thoughts. This was used to further refine the prototype and make it interactive for the following phase.

5.1.1 Design Critique

Some of the meetings with the team were utilized to receive feedback on the prototype as well as to gain better insights into the triage process. The following section includes findings from a meeting where the prototype from Figures (4.7, 4.8, 4.10 and 4.11) were showcased.

Personal Information Page

In many cases, the caller might not call for themselves. It is, therefore, necessary to include a field where the nurses can specify whether it is the patient calling themselves or if they are calling for someone else. Additionally, it would be beneficial to have the opportunity to select the relationship between the caller and the patient.

Free-text Field

The name choice of the free-text component in the prototype could be problematic as the term *"note"* (or *"notat"*) is frequently used to refer to the actual documentation in medical settings. Using the same term for a specific component that is meant to be an aid in the process and not the documentation can create confusion and make it harder for the users to understand the system.

There were also some disagreements about the placement of the free-text field. It was suggested that all the documentation should be placed together. While others liked the thought of visually differentiating the actual documentation from the tool used to help with the structural documentation.

Size of the Documentation

The documentation serves as an important component of the system and should be more dominant. It was suggested that it could be beneficial to have the opportunity to close the sections about personal information and contact information. Another possibility is to make the component bigger.

Path of Symptoms

It was suggested that displaying the entire path of a symptom is unnecessary as the nurses are already familiar with this information. Furthermore, it was said that this might result in too much information on the page, making it harder for users to navigate and read. However, displaying the path can also enable the users to more easily navigate up in the hierarchy and provide a shortcut for these actions.

5.1.2 Workshop

This section includes the findings and insights from participating in a workshop series conducted by RE-AIMED. These workshops aimed to get feedback from the nurses who had used the RE-AIMED prototype for a while. This provided a better understanding of the nurse's thoughts on the system, finding out what they liked and disliked and if they were missing any features. Although the purpose was to get feedback on the existing prototype, the insights from the workshop were used in the design process presented in this thesis as well.

The overall feedback from the nurses who used the prototype was that the interface appeared messy and challenging to use initially. They found the search engine to be the most frequently used feature, indicating that the suggestions provided were insufficient. Yet, in common cases such as a sick child, the suggestions were good and therefore made the documentation process quick. It should be noted that the prototype was primarily used after the conversation, so users already knew what they wanted to document and therefore making it easier to locate these symptoms via the search engine. At its core, the list of suggestions aims to provide help to the nurses in real time. As a result, the list will be continuously updated based on the symptoms in the documentation. This caused some frustration from the nurses when they saw multiple symptoms they wanted to document. When the nurse first documented a symptom from the list, the list was updated, leaving out their next step. Some users, therefore, expressed that they wanted the opportunity to select multiple elements or save elements for later use.

The users expressed different opinions on how to sort the symptoms in the documentation. Some wanted to place all the disconfirmed symptoms together at the bottom, while others preferred the current approach of placing the disconfirmed symptoms at the bottom of each category. The nurses said that they wanted a more distinct visual representation between the answered symptoms. It was suggested to use different colors to distinguish the confirmed and disconfirmed symptoms better.

Some said that they found it difficult to start the process. Different strategies were reported such as first searching for the "main" symptom of the patient and after using the suggestion list more. Others started directly with the suggestions by confirming and disconfirming the suggestions.

The findings above were feedback given by the users on an open question about what they thought about the system. We specifically used the nurses about their thoughts about additional information and prompts over the symptoms in the suggestion list, a text telling which symptom in the documentation the suggestion is connected to. Since some of the symptoms in the suggestion list are descriptions of the documented symptoms, such as asking about the duration of a symptom. In the version the participants used, the system does not provide information about where in the documentation these symptoms will end up if answered. For example, if the documentation consists of the symptoms, fever, and nauseous, it may be suggested to ask if the patient has had this before. However, it does not indicate what symptom it is asking about. We, therefore, asked the nurses if they had any thoughts on having a text over the symptom, that will inform the user what symptom it is connected to. The group in the first workshop expressed a clear desire for this feature. While the participants in the other groups wanted to test and use this feature before giving feedback.

Because of the different options on whether to include the path above the symptoms in the suggestion list or not, the participants were asked about their opinion on this. They did not have this feature in the prototype they had used but were shown examples of how this could look. It was important to ask their thoughts on this matter, to find out if this would result in too much text and information on the screen. However, the response from the nurses was that visualizing the paths could be more helpful than an obstacle.

5.1.3 Additional Requirements

Based on the findings from the two sections above, some additional requirements were added.

- The system should allow the nurses to input information about the caller.
- The nurses should be able to navigate back in suggestions.
- The system should allow the nurses to sort the documentation in different ways.
- Visual distinction between confirmed and disconfirmed symptoms.

5.1.4 Interactive Prototype

Based on the findings in the previous sections, the third iteration of the prototype was created. Similarly, to the previous prototype, this was also created in Figma. However, this third iteration of the prototype was created to be interactive. It was specifically designed for two cases that were used to evaluate the prototype in the next stage. While the goal was to make the prototype as interactive as possible for the nurses to experience its flexibility, it was necessary to reduce the number of actions at a given step to create the prototype. Figure 5.1, shows the interaction flow from the second case. The two cases that will be used in the evaluation include two callers and different reasons for contact. The figures presented in this section are, therefore, from the two different cases. The list of suggestions is used from the RE-AIMED prototype as well as the indicators of what symptoms could potentially be a red triage level.

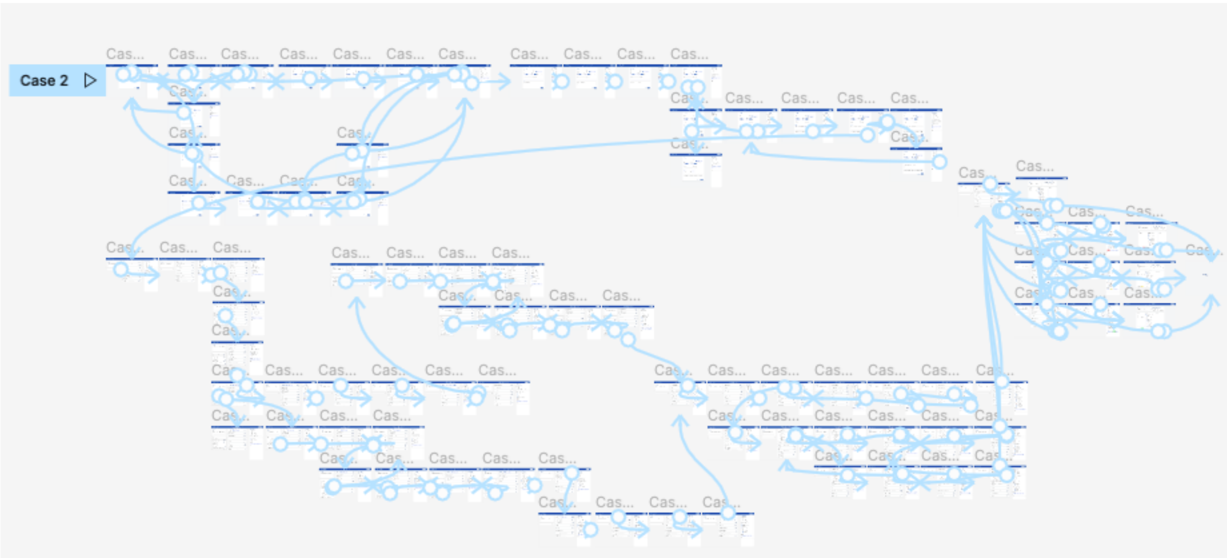

Figure 5.1: An overview of the interaction flow of the prototype from case 2.

Design Choices

In the process of creating the previous prototype, various color schemes were explored. In the third iteration, the colors were finally established. The primary colors of the prototype were blue, grey, and white. These were selected to keep the interface simple and with minimal distractions. Additionally, the selection of colors was limited due to the colors associated with the different triage levels. These colors should be restricted and only used when referencing these triage levels. The main colors for the final prototype can be seen in figure 5.2. The colors used for the corresponding triage levels can be seen in figure 5.3.

Figure 5.2: The main colors for the prototype,

Figure 5.3: The colors for the different triage levels.

Page 1: Personal Information

Figure 5.4 shows the new screen for the collection of personal information. It looks similar to the version in Figure 4.7, however, some changes were made. The name where the nurses can write the patient-initiated information or initial information is re-named to draft *("kladd")* instead of note. In Figure 5, the thought was to also suggest common symptoms, but in this version, these were removed. That was done to make a more distinct divide between this screen and the next. Therefore, only symptoms that correspond with the written text are suggested. While the user hovers over the suggested symptom below the field, the words that resulted in this suggestion will be highlighted.

To specify the patient's age, the users can first write the age and then select the measurement, such as months. The thought is that years will be the default measure, but the users can change it accordingly. Information about the caller was also added. As mentioned, the prototype sought to reduce the required actions to reach the goal. It was therefore decided to minimize the use of dropdown menus and display the alternatives when less than 6.

The documentation is located similarly to the previous iteration, but it is made bigger as a result of the design critique. It also allows the users to close and open the fields below personal information *("personalia")* to give more space for the symptoms. Instead of using a dropdown menu to hide the alternatives for the triage level, the alternatives are visible to the user.

Page 2: Exploration of Symptoms

Figure 5.6 shows the new screen for exploring symptoms. The documentation is larger on this page compared to the personal information page. This is because it will be used more in this phase compared to the previous one. Squares were used in front of each symptom in the documentation. This was added to provide the users with an overview of the listed symptoms. The squares also come in different colors, indicating different things for the users. In the workshop, the nurses requested a better distinction between the confirmed and disconfirmed symptoms. To better visualize this distinction, the squares have different colors for confirmed and disconfirmed. The confirmed squares are usually blue but can also be pink or red, depending on the context. If the squares are pink or red, this signals that the documented symptoms could result in a red triage level or a red triage level. Disconfirmed symptoms have a grey square in front of them, lighter text, and the prefix *"disconfirmed"*, see Figure 5.5.

Like the previous prototype *(Figure 4.8)*, the list of suggestions is in the center of the screen. A blue text is used over symptoms that are descriptive of already documented

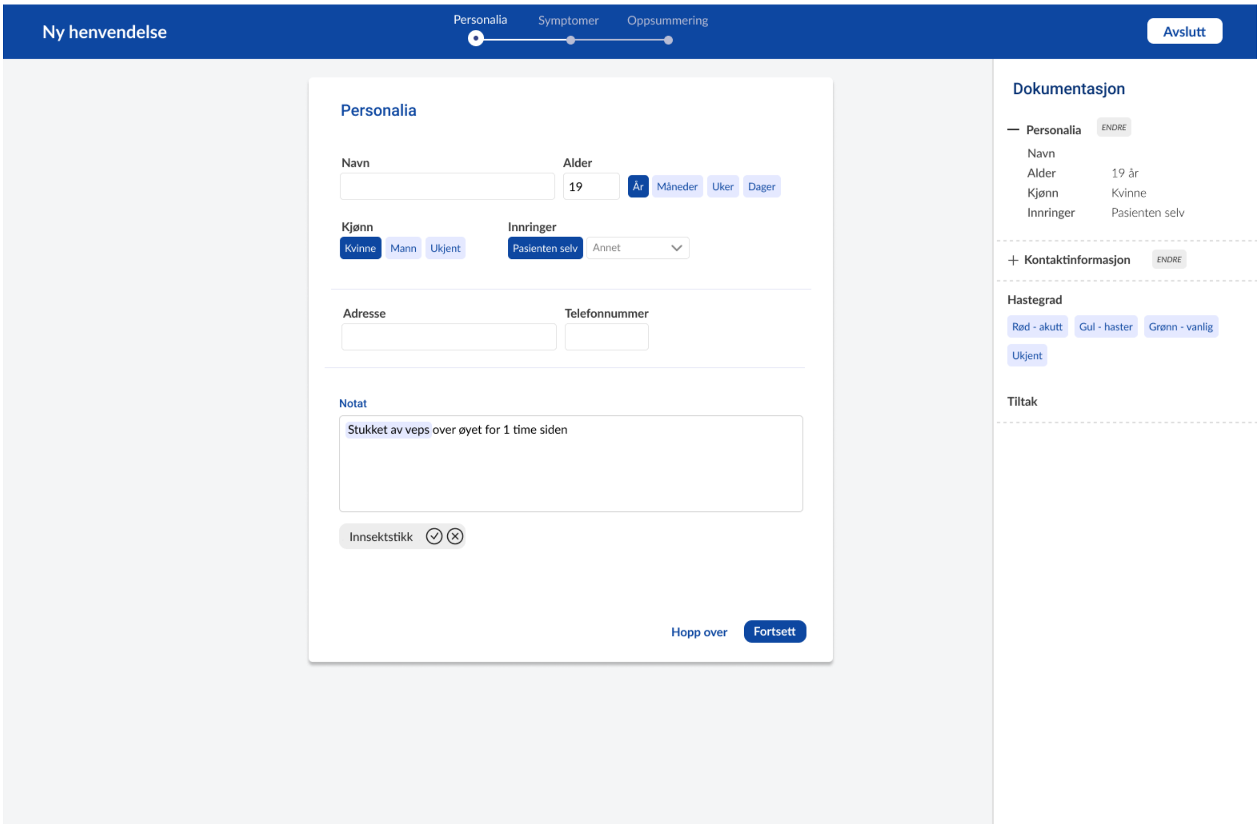

Figure 5.4: The screen for collecting initial information in the interactive prototype.

symptoms. This is done to show what symptom it is connected to and where it will end up in the documentation.

As mentioned earlier, the plus icon on the left side of the symptoms in the suggestion list indicates that there are elements below. To see these, the user can click on the plus icon, see Figure 5.7. To visualize that some suggested symptoms can indicate urgency or a red triage, these symptoms have a long red rectangle on the left side, see Figure 5.7.

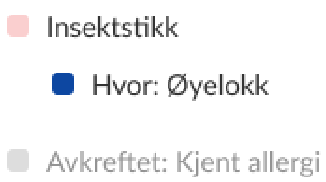

Figure 5.5: From top: confirmed symptom (could result in red triage level), confirmed symptom and disconfirmed symptom

Symptom Description and Location

The user can see the questions related to a symptom by clicking on the edit button beside the symptom in the documentation. Like the previous prototype, a new window will be displayed. However, instead of making the whole background darker, the new

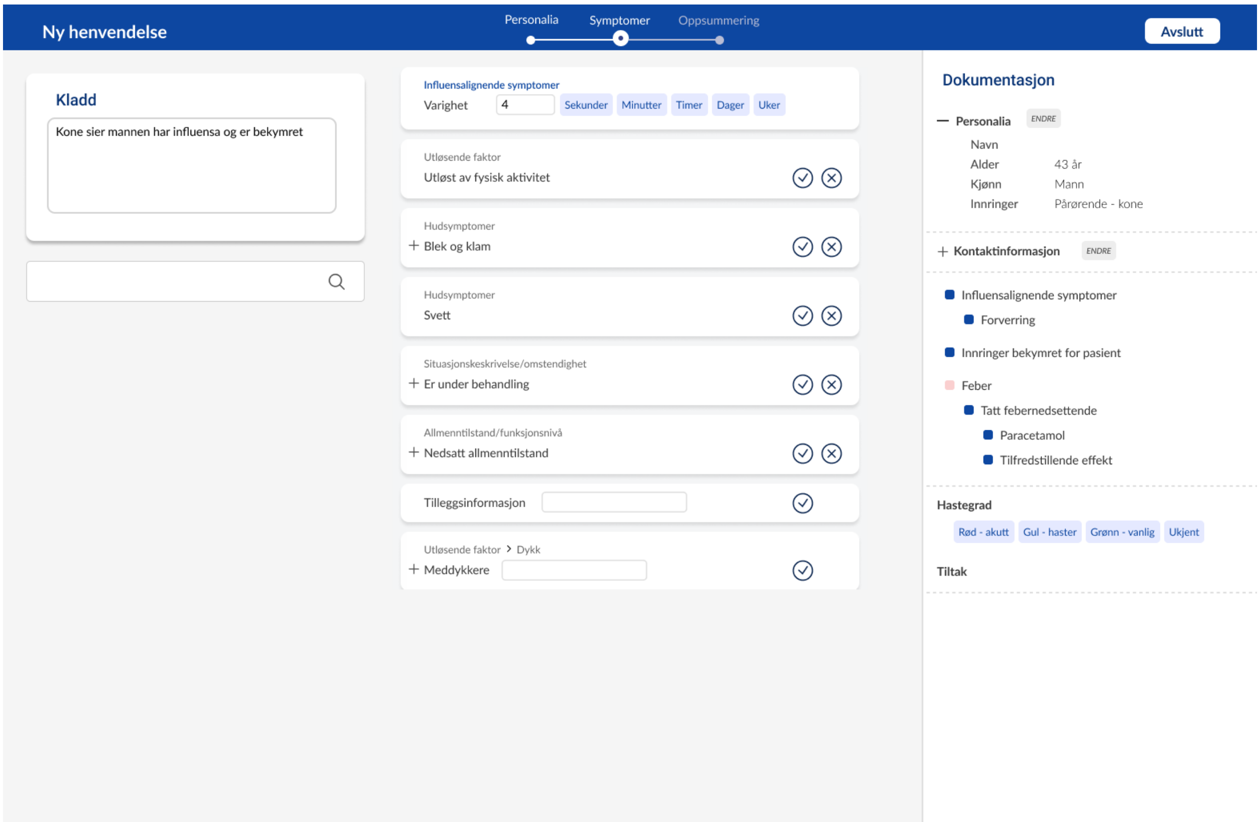

Figure 5.6: Exploration of symptoms, interactive prototype

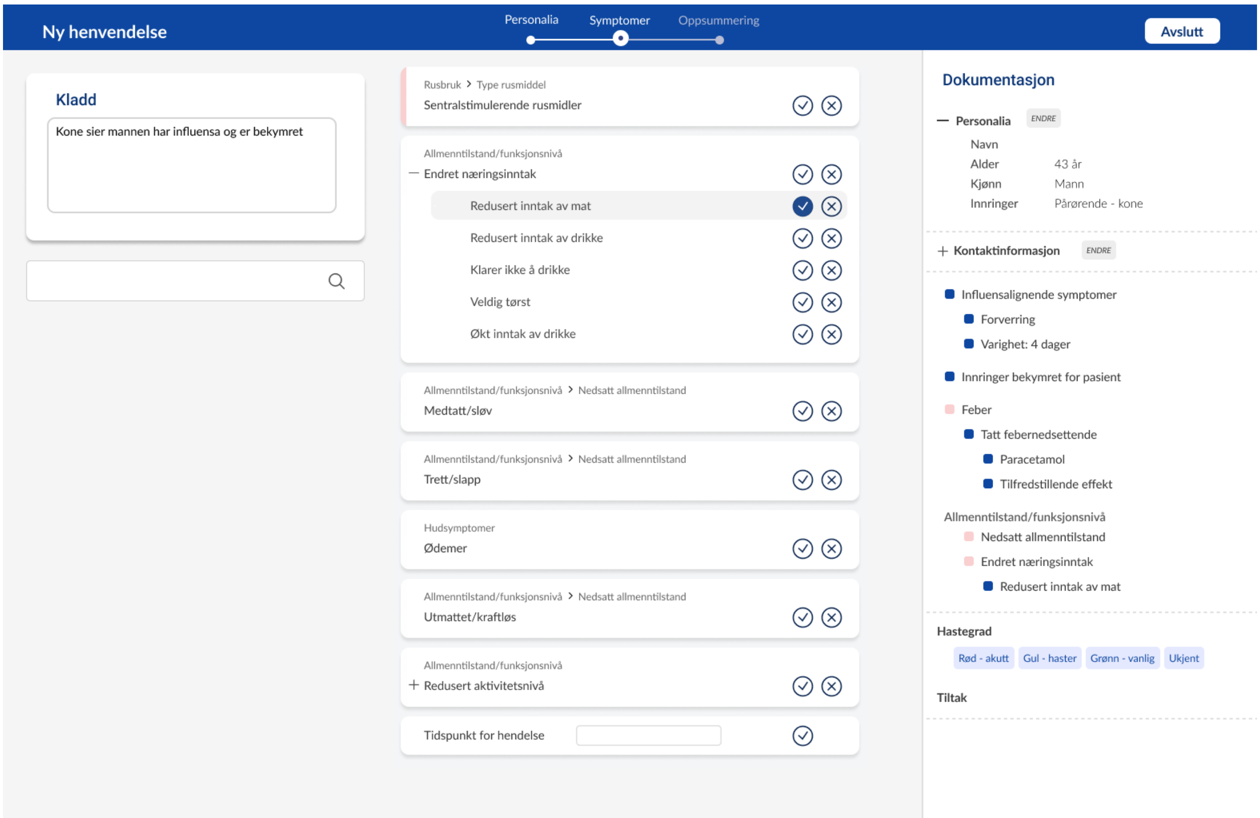

Figure 5.7: Exploration of symptoms: Visualizing how the users can navigate in the suggested symptoms.

window is placed over the list of suggestions. This was done to allow the nurses to easily see what has been written in the *"draft"* as well as the documentation, see Figure 5.8.

To tackle the problem of lack of visibility on the body map, the system can display each body part on the screen while the user hovers over it. Figure 5.9 shows an example of this.

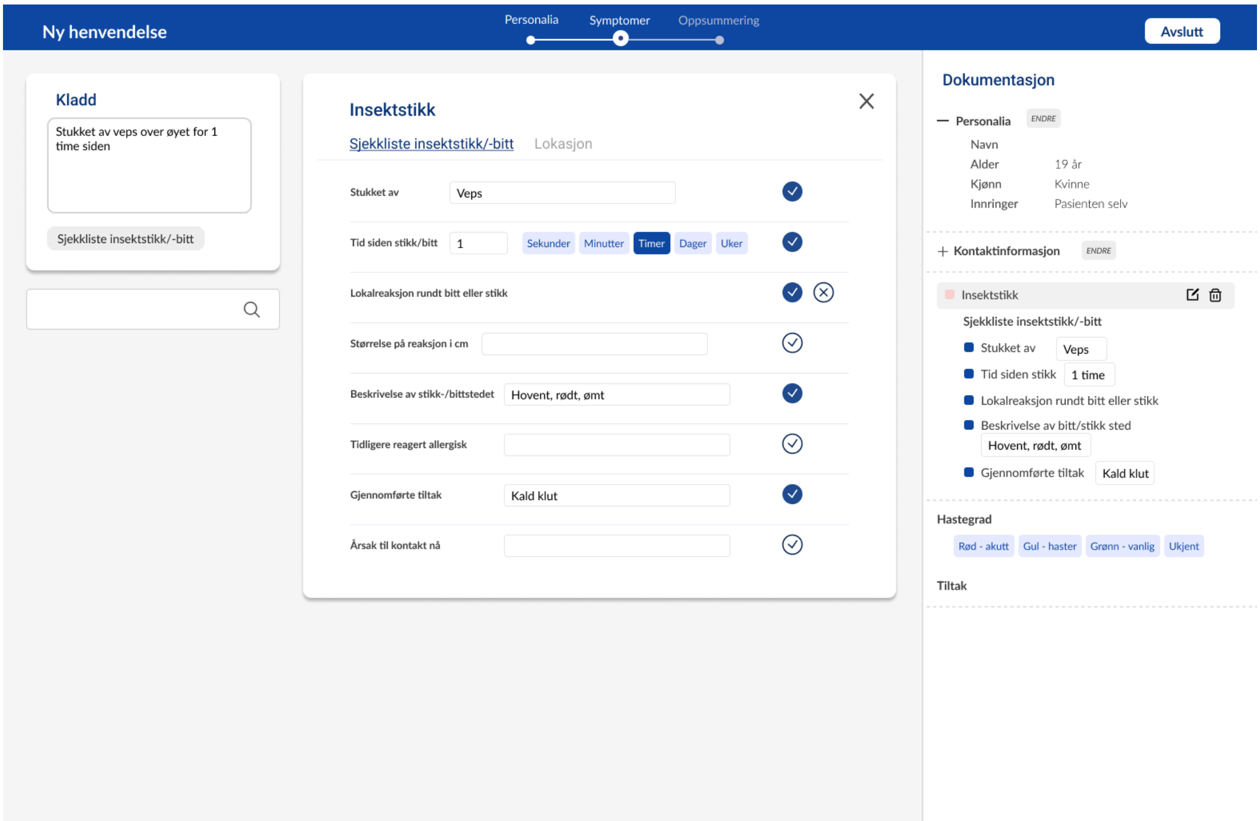

Figure 5.8: Symptom description: Pop-up page that allows the users to fill in descriptive answers to a documented symptom.

Searching for Symptoms

The search field on the left of the screen allows the users to search for symptoms. To better inform the users of their previous answers, or what has already been documented, the icons corresponding to the answers given are filled, see Figure 5.10. Since the documentation is on the opposite side of the screen, this is done so that the users don´t have to move their gaze to see if they have documented the elements shown in the search.

The paths to a symptom are visualized if they are not directly below their parent. Because of the restrictions in terms of the size of the search results, only two of the elements in the path are visible. This means that if the path has more than two elements, this will be visualized with three dots between the elements. Thereby, allowing the users to click on these dots to see the whole path.

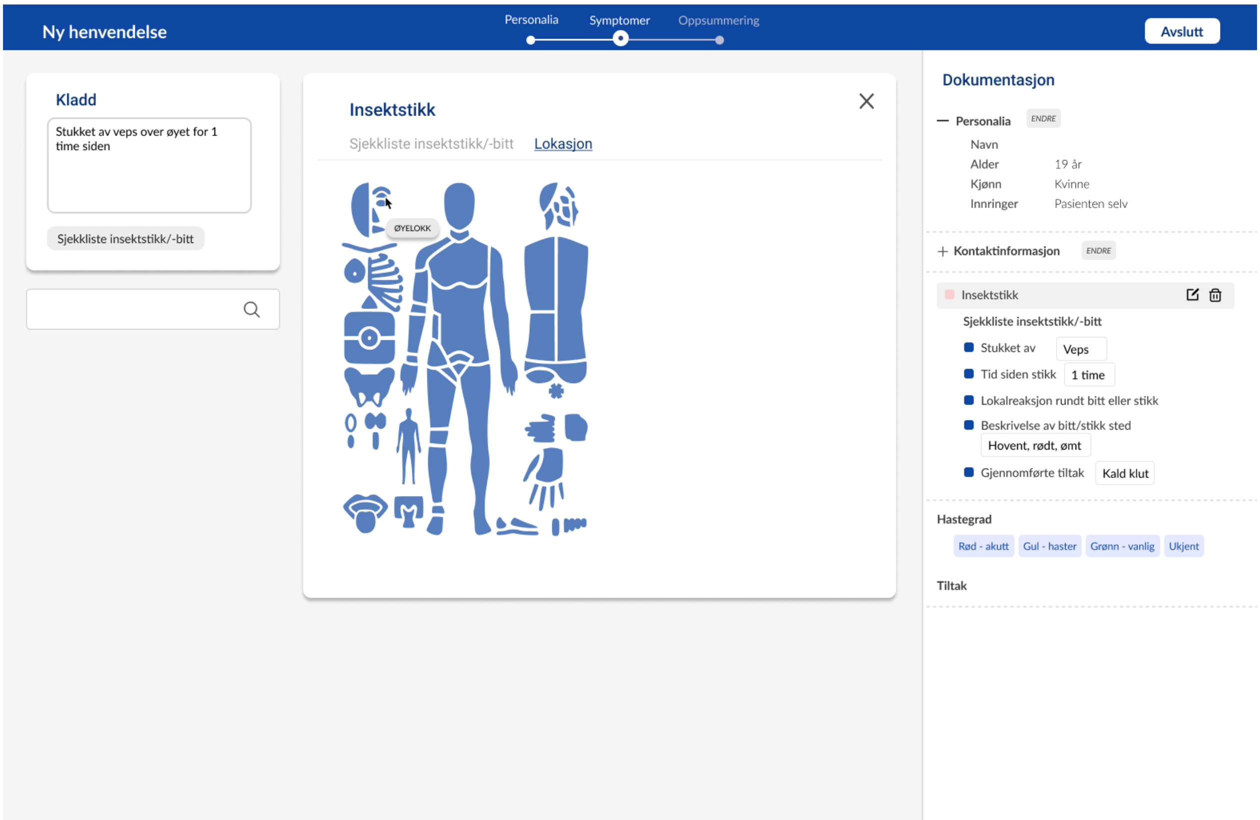

Figure 5.9: Symptom localization: Pop-up page to select the location of a symptom.

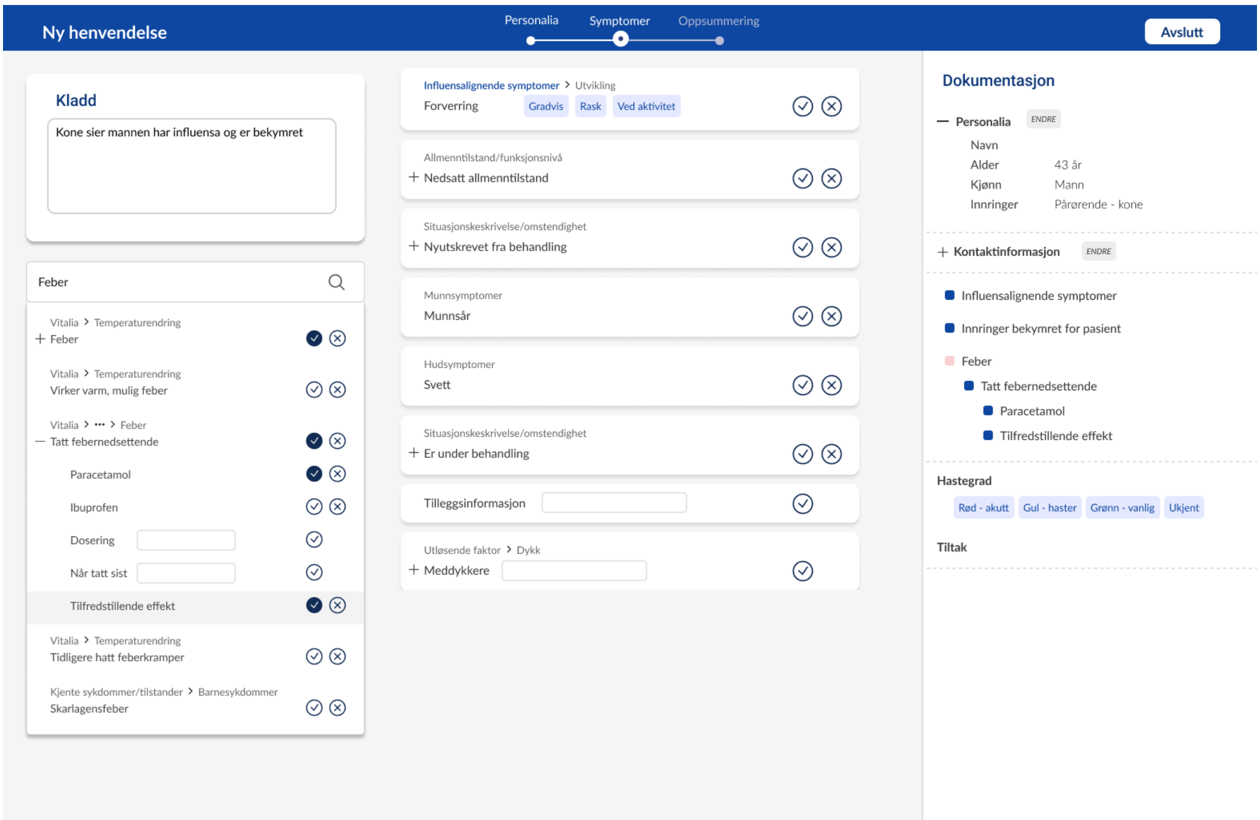

Figure 5.10: The search function in the interactive prototype

Summary Page

The third page was implemented including the summary of the encounter, see Figure 5.11. This was included to remind the users to see if all elements written in the free-text field had also been documented in the actual documentation. The page includes a field that says, *"Did you remember to add everything"*, the thought here is that the system can recognize the symptoms and locations written in the text. If the system recognizes any elements that are not in the structural documentation, the user will get a reminder or notification to document these.

A summary of the documentation is presented, dividing the confirmed and disconfirmed elements into two sides. The summary will also include the triage level that is chosen as well as the advice that is given to the patient.

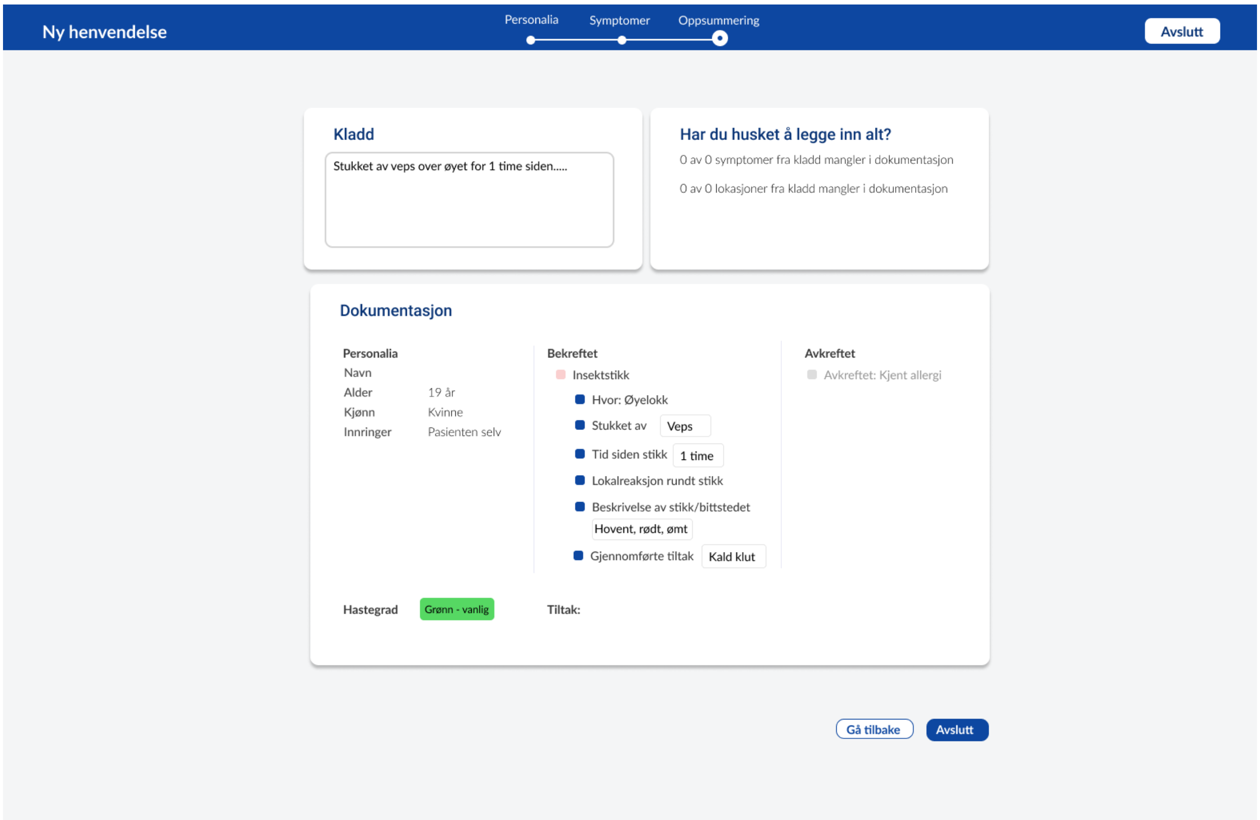

Figure 5.11: The last page of the interactive prototype: summary

5.1.5 Summary

The third phase in the design process included a design critique and participating in a workshop. The findings from these were used to create additional requirements for the prototype. This phase resulted in an interactive prototype created in Figma. The prototype was made interactive for an evaluation with users for the next phase.

5.2 Phase Four: Evaluating with Users

The fourth phase of the design process includes an evaluation of the semi-interactive prototype. A pilot test was first conducted to ensure that the interactions in the prototype were right. Telephone operators were then invited to test and discuss the prototype. The findings from this phase resulted in additional requirements for the final prototype.

5.2.1 Pilot Study

Before evaluating the prototype with telephone operators, a pilot study was conducted to ensure that the prototype worked as intended and also to practice the setup. The pilot study was conducted with one participant. Although this participant didn't have a clinical background like the real users, it helped to refine the interactions and make sure it worked as intended. Additionally, it provided some feedback on the interface.

One suggestion was to add a back-and-forth button to the symptom exploration page, as navigating only through the header could be difficult. The first and last pages already had this feature, but the main page didn't. Adding the same buttons to the symptom exploration page would therefore give more consistency. Due to time restrictions, this change was not implemented before the workshops, but the participants were informed that this would be implemented in the future.

5.2.2 Interviews and Evaluation with Users

Telephone operators were invited to evaluate and discuss the prototype as well as to provide insights into their current workflow. The prototype used for the evaluation was interactive in the sense that the users could navigate through the different pages. However, it did not fully demonstrate the extent of flexibility the system would possess if it were fully developed. As a result, the users did not have the opportunity to use all buttons and features at any given time, as they would in a real-life setting. In addition, the tool used to make this prototype did not allow text input in real-time. To account for these limitations, the prototype was therefore designed for two cases that were used in the evaluation.

Participants All the participants were currently working as telephone operators, but they had different levels of experience ranging from three to twenty-three years.

Workflow

To start, the participants were asked to share their experiences with the current triage tool they use. This was to gain more insights into what they found challenging, how they used the tool today, and how they wanted it to work.

The participants expressed that it could be difficult to find and select the appropriate chapter for the problem the patient presents. This was because they felt they were missing certain categories or if the patient presented different problems. One of the participants said that they were missing a feature or assistance to help them select the appropriate chapter, for example, by using search words. In the case when the patient presents multiple problems, the nurses had to navigate back and forth between the chapters and connect these in the documentation by using multiple discriminators from different chapters. The discriminators within each chapter reflect the triage level. The nurses expressed that these could be vague, and the system, therefore, had too much room for individual judgment and had to rely on their experience. Because of these vague and small differences between the criteria numbers, they felt that this could lead to inconsistent triage decisions between the telephone operators since this vagueness always allowed them to set a red triage. However, at the same time, they expressed that they felt that they often had to select multiple criteria numbers within the chapter to fully document the patients' problems.

Next, the participants were asked to describe the typical flow of a conversation during a triage call. The phases mentioned in the background were used as a starting point, collection of personal information, problem formulation, exploration of symptoms, selection of measures, and then giving advice. The participants said that they tried to follow these phases during triage. However, they often face the challenge of patients presenting their problems before identifying themselves. The general feedback was that the participants had to stop the patients so they could search and find the patient to assign the medical note to the correct person. It was also said that it could be challenging to navigate the triage tool when the patient provides a lot of information at once because the way the patient presents themselves and their problem often do not follow the initial phases of the triage.

Most of the participants said that they regularly use pen and paper when doing the triage to write down keywords of the problem the patient presents. This is done to help the nurses remember what has been said and to get an overview of the situation. If the patient had more than one problem that was bothering them, this method is used to prioritize the problems.

Reassurance

One of the most important tasks the nurses do in the triage process is related to the human-human interaction between the operator and patient. They should provide information to the patient, reassurance, and make the patient feel understood. The callers can be at their most vulnerable and taking the time to provide this reassurance is important.

"It is about reassurance and providing information. So answering the phone within two minutes and then moving on to the next call, it takes time. Your role is to provide reassurance, and if the patient does not feel safe, they should come here. Reassurance, reassurance, reassurance. – Participant 1"

"And when you're sick, you're also vulnerable, right. The patient should feel seen with their problems, but whether it needs to be examined or not, I understand that. Because you can ́t invite everyone here, sometimes they will have to wait. But then it is very important to give reassurance and that the patient has been understood." – Participant 4

Working Experience

Nurses who had a great experience working as telephone operators expressed that they felt they knew the triage tools that they regularly used by heart. While the tools were helpful to remember important questions to ask, or when being faced with uncommon situations, they often knew what questions to ask in regular situations. Therefore, they often started to ask questions before opening the triage tool.

"I am automatically ahead when a patient says something, I know, so I already have the questions ready. So you sort of dive right in, and it really depends on experience." - Participant 1

"You can't just sit there and search, like oh, you have a headache, just wait a moment. Stomachache, yes, where is the stomach chapter? Are you sweaty, or pale? You're immediately on the questions, and then you're back, okay, yeah, so, were you pale or not pale? It's humans, you can't just say wait a moment, where are we in the index." - Participant 1

The "Draft"

The participants were generally positive about the free-text field and appreciated a placeholder to jot down notes for themselves. They liked the idea that it could work similarly to the paper notes that are already used but be integrated into the system.

"But this looks very good. I loved the draft thing, it replaced the paper that I usually have and I am completely dependent on it because I am so afraid of forgetting something and things I need to check further." – Participant 1

They said that it could be especially helpful to collect and get an overview of what the patient says because navigating through searches and suggestions can be time-consuming when they are presented with much information. They said that it could help them in the process to remember their train of thought and to prioritize the symptoms the patient presented. The participants were also asked about the placement of the field, and the response was that they liked the placement, and it made it easy to see. In addition, it was also nice to have it available on all the pages.

"I think it's fine, that it can hang there so you can see can see it all the time" – Participant 2

In the prototype, the free-text field had two purposes. On the initial page, it was used to write down text and based on the text give some suggestions to the user. While on the exploration page, the field was used as a reminder of what had been said initially and to use the field to do a search. However, the nurses said that it could be helpful to still get the suggestions based on the text.

"If I had written, had a fever for an hour and temperature of 40. Couldn't the machine then read fever and come up with suggestions like that? So when you are sitting there and writing, then fever pops up and you can just throw it in?" – Participant 3

Two of the nurses expressed that they wanted the text in the field to also be a part of the documentation because the field can reflect how the nurses handled the situation and how they prioritized it.

The Suggestions

The nurses were asked to provide feedback on the list of suggestions. One participant suggested that it could be helpful and save time by reminding the operator of important questions to ask. They emphasized that it was important not to present too many elements because this can be overwhelming and steal focus from the patient. Another participant also said that it was important that only relevant symptoms and questions for the current case were suggested.

"Just the fact that you can click on something and the questions come up automatically, and I mean that you shouldn't be overwhelmed by things, because then it can be too much." – Participant 1

Some of the participants said that some questions could be difficult to confirm or disconfirm because they can be too vague and have different meanings for the nurses and the caller. They emphasized the importance of asking concrete and simple questions that the caller understands. This is because the caller may tend to answer "yes" to a symptom if they do not fully comprehend it. As a result, it could be challenging to include symptoms such as *"general malaise" ("nedsatt allmenntilstand").* It was suggested to have alternatives below such as checkboxes, for example, the alternatives; *"been in bed all day"*, *"walked around the apartment"*, and *"been outside the house"*. These could make it easier for the nurses to convey in a way that the patient understood. Another alternative is to use an input box, where the nurses could write why they selected this symptom. However, with more concrete symptoms using confirm and deny buttons would be sufficient. Furthermore, it was suggested that the system could provide examples of how to phrase the questions.

"For example, general malaise, you could have some boxes below. Spent the day in bed, walked around in the house and been outside the house. Three boxes that you can select. It has to be very concrete and simple." – Participant 2

The participants were asked to document that the symptom had worsened. As mentioned earlier, it was decided to show the alternatives for the users. However, when being asked to only document that the symptom had worsened and therefore not selecting one of the alternatives, the users had difficulties finding *"just worsened"*. When they used the suggested question *"time since"* where they had to select a time measure, they easily managed the task. This may suggest that the alternatives should only be shown when they must select an alternative.

One of the participants expressed concern about the suggestion list being updated after confirming or disconfirming a question. As mentioned previously, the purpose of the list of suggestions is to assist the nurses in real time, meaning that the list will be continually updated based on the documentation. However, this concern indicates that the nurses need to have more freedom to navigate back and forth in the different suggestion lists.

"But you can't go back? Can't you go back and look at the option one more time? Now I don't remember what was written below." – Participant 4

Documentation

As mentioned above, the nurses liked the idea that they could confirm and disconfirm concrete symptoms. However, they felt that this could be too limiting because some symptoms required an explanation. This would also be in the case where the nurses had a different perception of the symptoms presented by the patient. It was therefore said that it was necessary to have the possibility to further explain the symptoms in free text.

"But I think that if I'm sitting in the emergency medical call center, then I must describe it, if you say that you have reduced food or drink intake. And then I must describe it more, I can't just say it like that. Maybe he hasn't eaten in 14 days, or eaten just one slice of bread in 10 days. Or a child who hasn't had a drink in two days. So I have to define how much on everything" – Participant 2

It was also mentioned that it would be beneficial to also have the possibility to add a free-text field below the contact information section. This could be used to write further about the contact information the caller presents.

Linear Design

The participants were asked that the design follows a linear flow. The general response was that this could be helpful. However, it needs to be visualized and easy to navigate back and forth without requiring too many clicks. In addition, the patient doesn't necessarily follow the path or steps the nurses usually follow, so the system must be flexible to capture the information presented by the patient.

Body Map

The participants were asked if there was something they found challenging. Two of the nurses mentioned that the body map was a bit weird and could be difficult to use. They raised concerns that it could take require too many clicks and that the body parts could be too specific. It was suggested that it would be beneficial if they had the opportunity to search for a location instead of only clicking on the map. Additionally, the nurses said that having an overview of the human body and its organs would be helpful in cases where the patient describes pain in a specific area or when the patient refers to organs when describing their pain. It was also suggested that using different colors on each of the organs could be beneficial.

It would be very nice to have a picture of the human body and the organs, because, if the patient says that they have pain in the lower stomach, then you have to think, what was in the lower stomach, it's the appendix, of course" – Participant 4

"And some people just say, 'I have pain in my spleen.' Okay, where is the spleen?" – Participant 3

Decision Support

The prototype used in these evaluations did not include decision support when selecting the triage level but rather assisted the nurses when exploring the symptoms and documenting them. The nurses reported that they had some difficulties with the decision support that they were currently utilizing. Such as selecting the appropriate chapter and criteria numbers. The nurses also felt that the criteria could be vague and therefore required individual judgment. However, they were an aid when selecting the triage level and in addition, works as an explanation as to why the triage level was chosen.

It was desired to get assistance to find the corresponding chapters or criteria from the Norwegian Medical Index based on the documentation. Either by selecting the most important symptoms to use as search words or using the documentation as a whole. In addition, one of the nurses expressed that it could be helpful to see which triage level the system suggests.

"I miss having some search words or something that can guide you into different categories." – Participant 4

"It would be a very good tool to have, to get a confirmation of what I am thinking, that it corresponds to, that it can understand that it is red and not green." – Participant 3

Giving Advice

Giving health advice to the patient is a crucial part of telephone triage. It was expressed that the system must include a reference guide for advice. Including a reference guide for advice is important because it serves as a reminder of what advice to give in specific situations. Moreover, it could save time if nurses could easily select the appropriate advice from the guide. However, nurses also mentioned that in most cases or recurrent situations, they were already familiar with the advice to give. Therefore, having to navigate through a list of options to document the advice given would be more frustrating than helpful.

If the case corresponds to a red triage level, the nurses will contact the Emergency Medical Communication Center, and the nurses will therefore not provide any advice for the patient. However, for the two remaining triage levels, it was said that the health advice could correspond to the selected triage level, since the type of advice may vary based on the level of triage. To address this, one participant suggested that they could see the list of advice after selecting the triage level. Another possibility is to visualize what triage level the advice corresponds to.

5.2.3 Additional Requirements

Based on the findings from the pilot test and evaluation with users, additional requirements were added.

- The free-text field should continue to give suggestions in the symptom exploration phase as well as advice.

- Vague symptoms, or symptoms that could have a different meaning for the patient and nurse, should be more specific or have checkboxes below.
- Back and forth buttons between the pages.
- Allowing the nurses to also search for body parts when locating a symptom.
- Visualizing organs on the body map.
- Include a page for advice.

5.2.4 Summary

The fourth phase included an evaluation of the prototype, both by conducting a pilot study and evaluating with telephone operators. These findings resulted in additional requirements for the prototype.

5.3 Chapter Summary

This chapter presented findings from a design critique, workshop with nurses, pilot study, and evaluation of the prototype with users. These findings served as a basis for the additional requirements for the prototype. A third iteration of the prototype was presented and the requirements for the fourth and final iteration of the prototype were set.

Chapter 6

Results: Final prototype

This chapter presents the fourth and final iteration of the prototype. Most of the requirements that were set from the preceding phases have been implemented in the prototype, while some remain for future work.

6.1 Final Requirements

Requirements implemented:

- Enable navigation between the suggestions.
- The draft field should continue to give suggestions also in the symptom exploration phase.
- Back and forth buttons between the pages.
- Enable for search when selecting the location.
- Include a page for advice.
- Display preformulated questions for the suggested symptoms.
- Allow the users to explain why vague symptoms were selected.

Requirements remaining for future work:

- Support alternatives to sort the documentation.
- Visualize organs on the body map.

6.2 The Prototype

The prototype aims to aid the nurses during telephone triage. The sections below explain the changes done to the prototype and how these are intended to support the nurses in the triage process.

6.2.1 Personal information

In the initial page of the prototype, Figure 6.1, intended to support the nurses when collecting the initial information from the patient, minor changes were made compared to the third iteration, 6.1. The header was updated to include a page for advice. Additionally, some changes were made to the color choices for the inactive alternatives. This change was done to distinguish inactive and active elements better. For the suggestions based on the text, a border was added to the element when hovering to give better feedback to the user.

In the documentation that is visible on all pages, a new field was added. This is called assessment *("vurdering")* and includes a text field, where the nurses can write an explanation as to why they selected the different triage levels if needed.

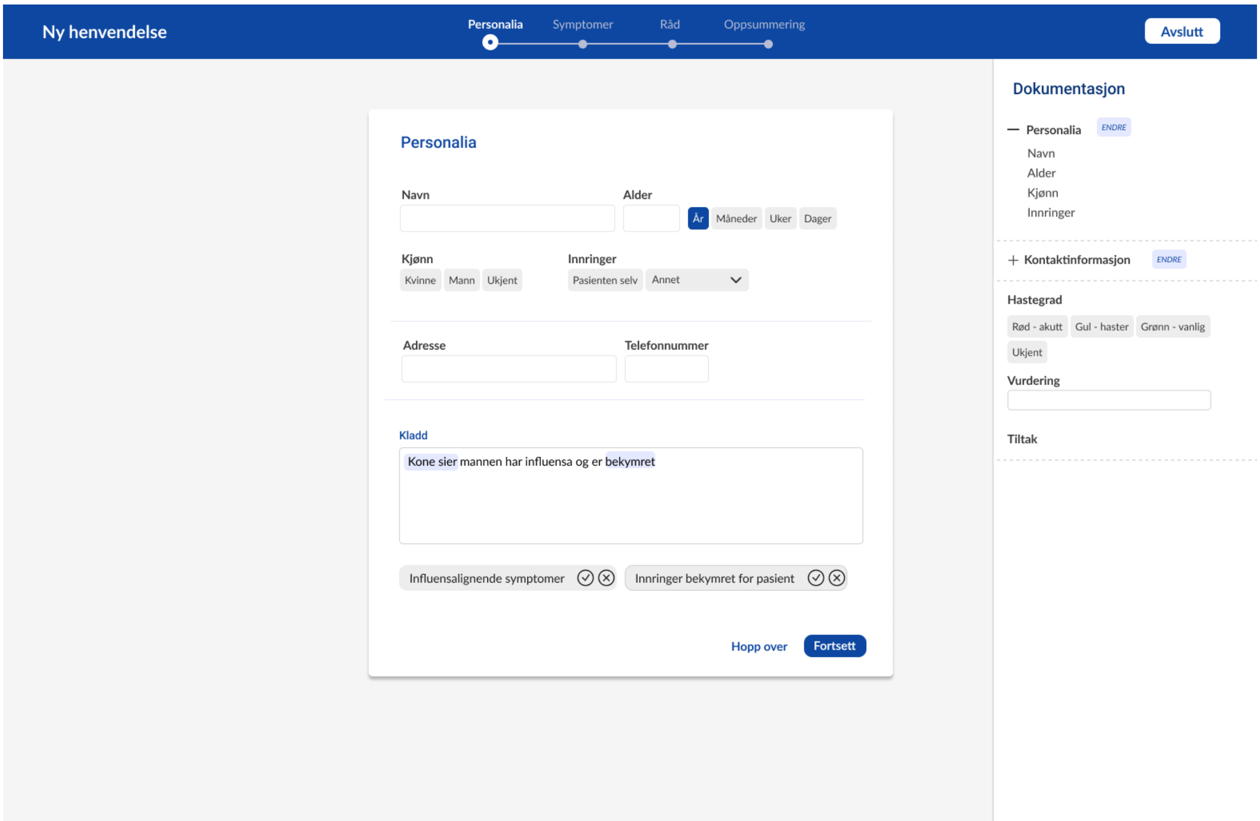

Figure 6.1: Initial phase of the prototype, final prototype.

6.2.2 Symptom exploration

For the page meant for symptom exploration, some changes were made. These are explained in the sections below.

Free-Text Draft

The element containing the free-text draft was made larger to make space for the suggestions below, see Figure 6.3. From the workshop, the nurses desired to continue to use this function to write notes to themselves as well as to get suggestions on what had been written. The space right below the text is therefore a placeholder for the suggestions. These suggestions will be based on what the user has written in the text field above, see Figure 6.2. Similarly, to the first page *(collection of personal information, Figure 6.1)*, when the user hovers over a suggestion, the text causing the suggestion will be marked with a blue highlighter. The user can directly confirm or disconfirm the suggested symptom by using the corresponding buttons or clicking on the symptom to see the symptom and its parent and children in the search. Additionally, the users could double-click on one of the written words to do a search for that.

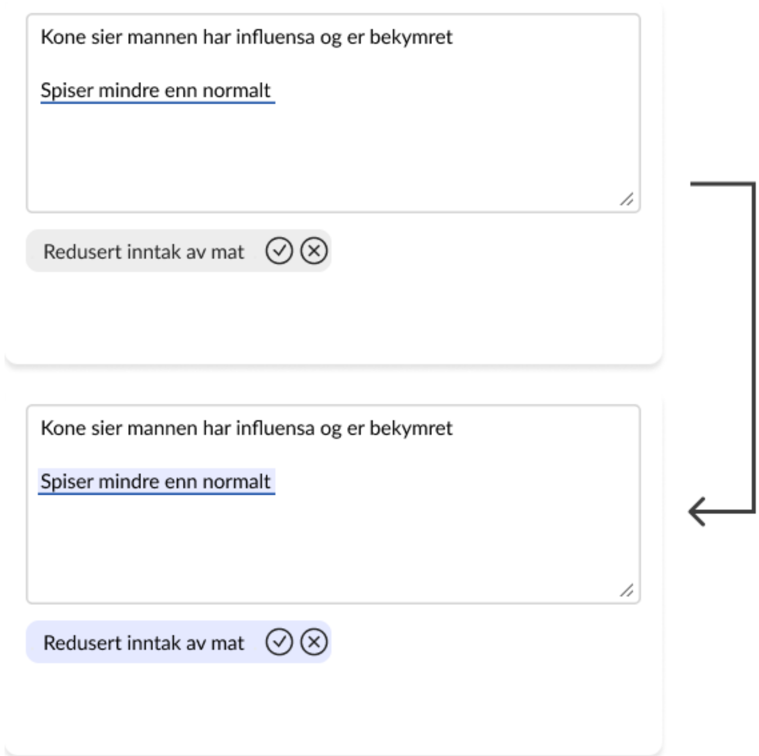

Figure 6.2: Visualizing how words from the draft can make structured documentation

Search and Symptom List View

The search bar is placed below the *"draft"*. It includes a standard search bar that allows the users to search for symptoms. In addition, a list symbol is placed on the left side. Feedback from the design critique revealed that the previous visualization of the list appeared messy. Nevertheless, this feature could be useful and should be incorporated into the interface. Rather than displaying the list by default, a list button has been introduced to enable nurses to view the list. This was done to reduce the text in the interface while still being available if needed. The list will be presented in a similar manner to the search results, see Figure 6.3.

Navigation

To make it easier to navigate between the different pages, a back-and-forth button was added at the bottom of the screen. Additionally, the findings from the workshop (held by RE-AIMED) and evaluation with telephone operators revealed that it would be necessary to go back to the previous suggestions. To support this, navigation buttons were added at the top of the list of suggestions. The buttons are meant to only be visible if the action is available. If the list of suggestions has been updated, the users can click on the back button to see the previous list, see Figure 6.3. If the user has navigated back to previous suggestions, two buttons will be displayed. These are a fourth button and an *"update" ("oppdater")* button. By clicking on the update button, the suggestions will be updated based on the current state of the documentation, see Figure 6.4.

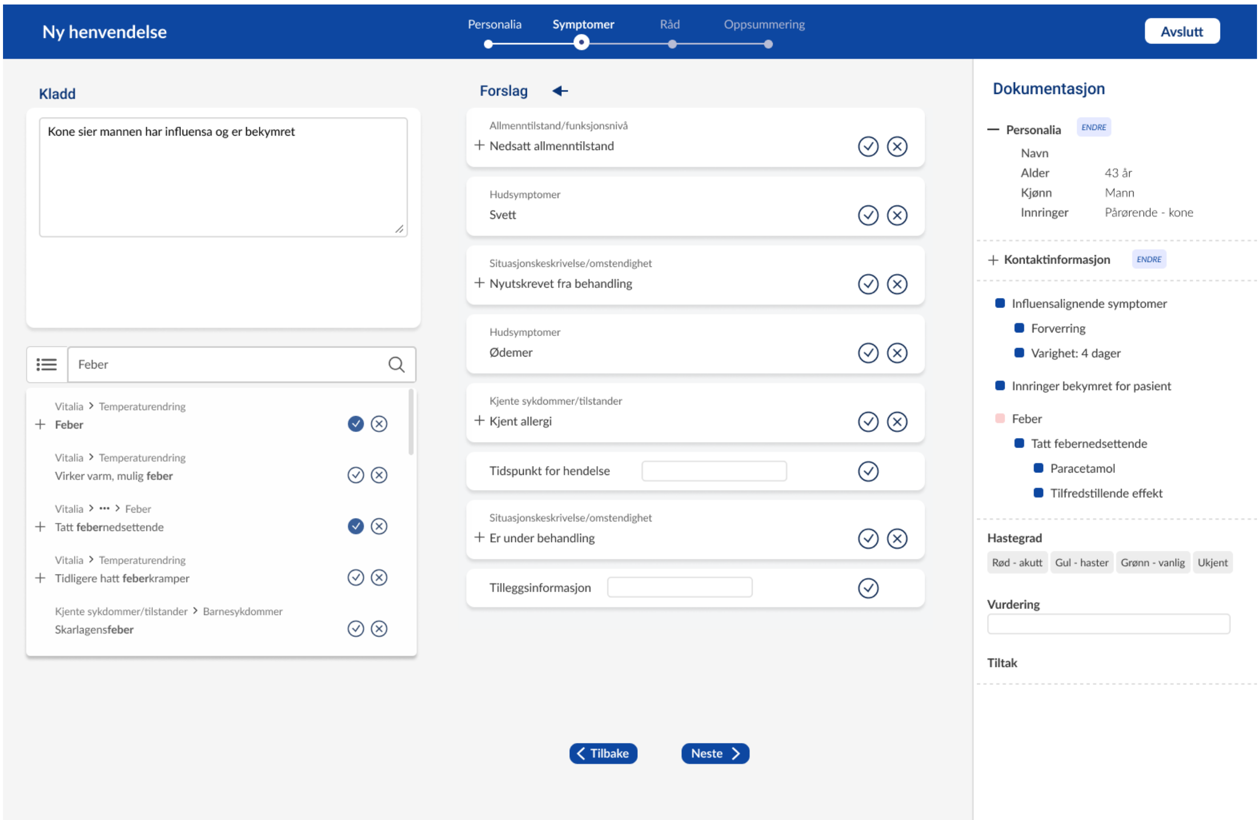

Figure 6.3: Exploration of symptoms, final prototype

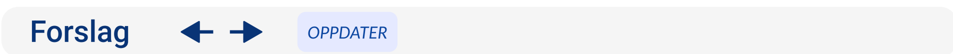

Figure 6.4: Navigation for the list of suggestions, back-and-forth and update

Extra Alternatives

Some symptoms can be vague and mean different things to the nurses and the caller. While a part of the clinical expertise is to rephrase medical terms to everyday language, the nurses saw this as a potential obstacle when confirming and disconfirming symptoms. Therefore, in the list of suggestions, when the user hovers over a symptom, a vertical ellipsis is visible, see Figure 6.5. When clicking on this icon, the user can see an example of how to rephrase the questions to the patient, as well as select concrete alternatives. The thought is that when selecting one of the alternatives, the parent symptom will be confirmed. In addition, there is also a free text field where the nurses can type in information as to why the symptom was confirmed or disconfirmed. The icon to see the elements below is still reachable through the plus icon.

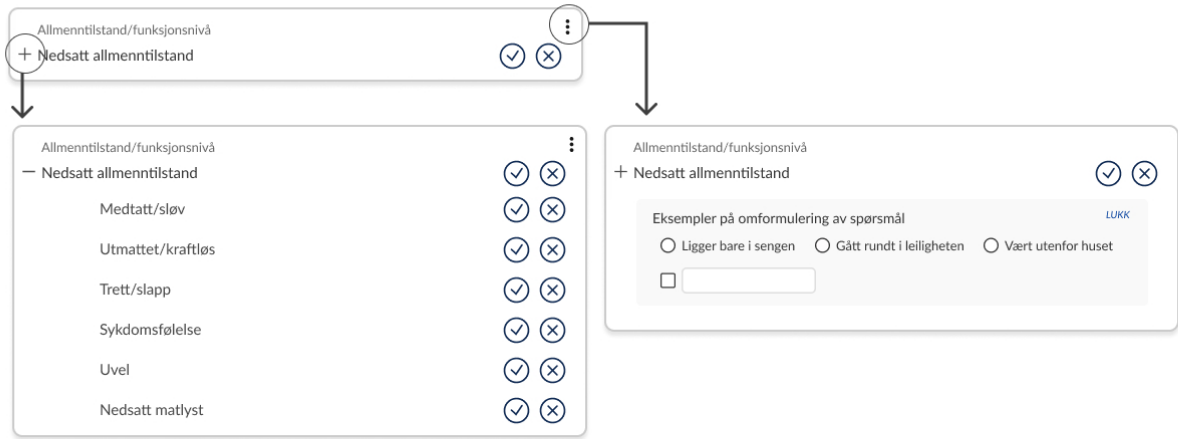

Figure 6.5: Final prototype, visualization of the different actions, see options and see children

Symptom Localization

When locating the symptoms, the nurses wanted the opportunity to search for the body parts. It has therefore been added a search bar in the window that can be used to search for symptoms, see Figure 6.6. Although the user expressed that the body map itself was problematic, these changes were not prioritized and remained for future work. It was also expressed that it could be helpful to have the opportunity to see the placement of organs. The users have, therefore, the opportunity to select *"show organs" ("vis organer")* to see the additional information on the body map. The map will, as default, not show the organs but rather leave it as an option.

6.2.3 Selecting Advice and Discriminators

A new page was introduced based on the feedback from the workshop, see Figure 6.7. This screen has a similar layout to the previous page *(symptom exploration, 6.3)*. It includes a proposal for how we can visualize the predictions of triage levels from the system. Instead of only showing one predicted triage level, one could show the likelihood of each of the triage levels.

The page also includes a list of suggested discriminators that could be relevant in the given situation based on the symptoms in the documentation. These are ordered by their urgency and are meant to assist the nurses when selecting the triage level. Each element containing the discriminators is marked with its corresponding triage level, to easily see the triage level. Additionally, they include the title of the criteria, as well as the number and description.

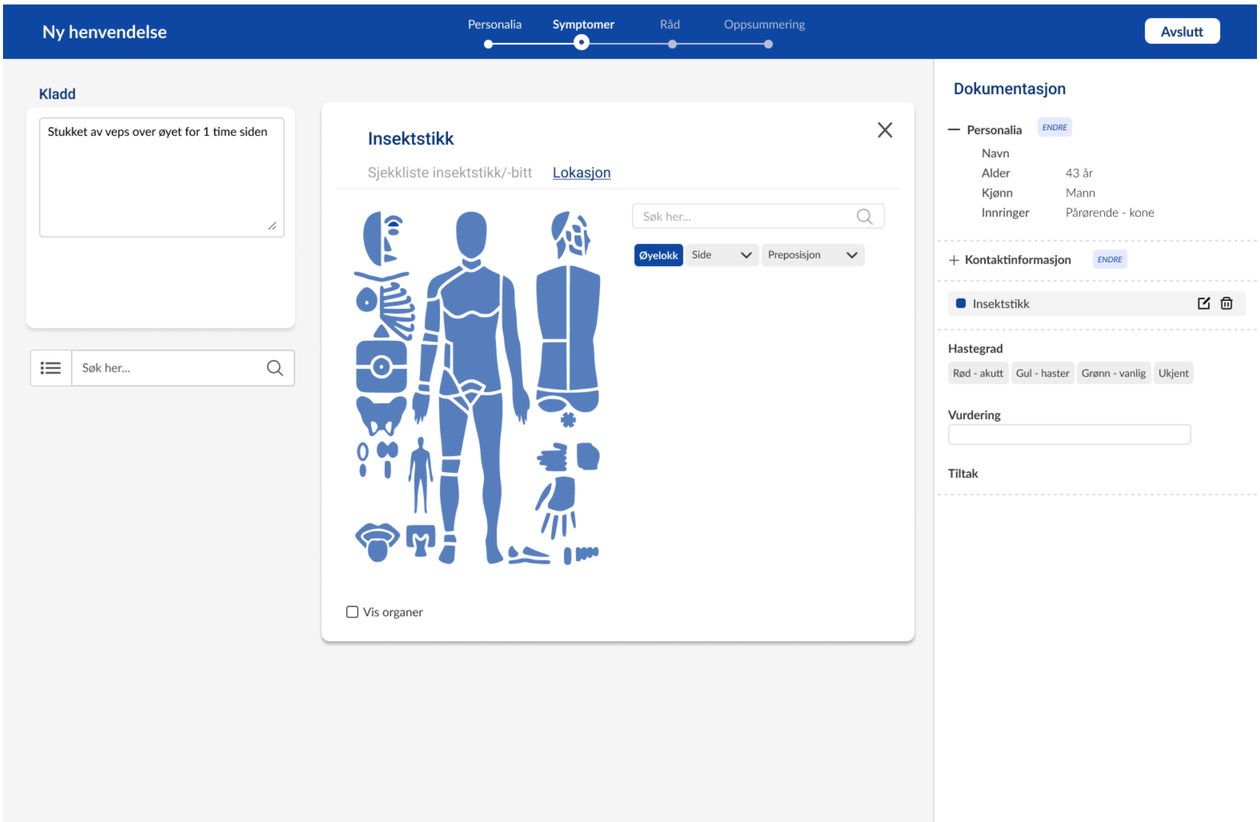

Figure 6.6: Enabling the users to search for locations and visualize organs.

The user can scroll below the discriminators to see the advice that is suggested to give in this situation. Each of these has a confirm button that the user can click on to confirm that they have given the advice to the patient. These will be visualized in the documentation below measures *("tiltak")* accompanied with *"advice"* above.

6.3 Chapter Summary

This chapter described the high-fidelity prototype that was created based on the insights and requirements from the preceding phases. Although most of the requirements were implemented in this version, some still remain for future work.

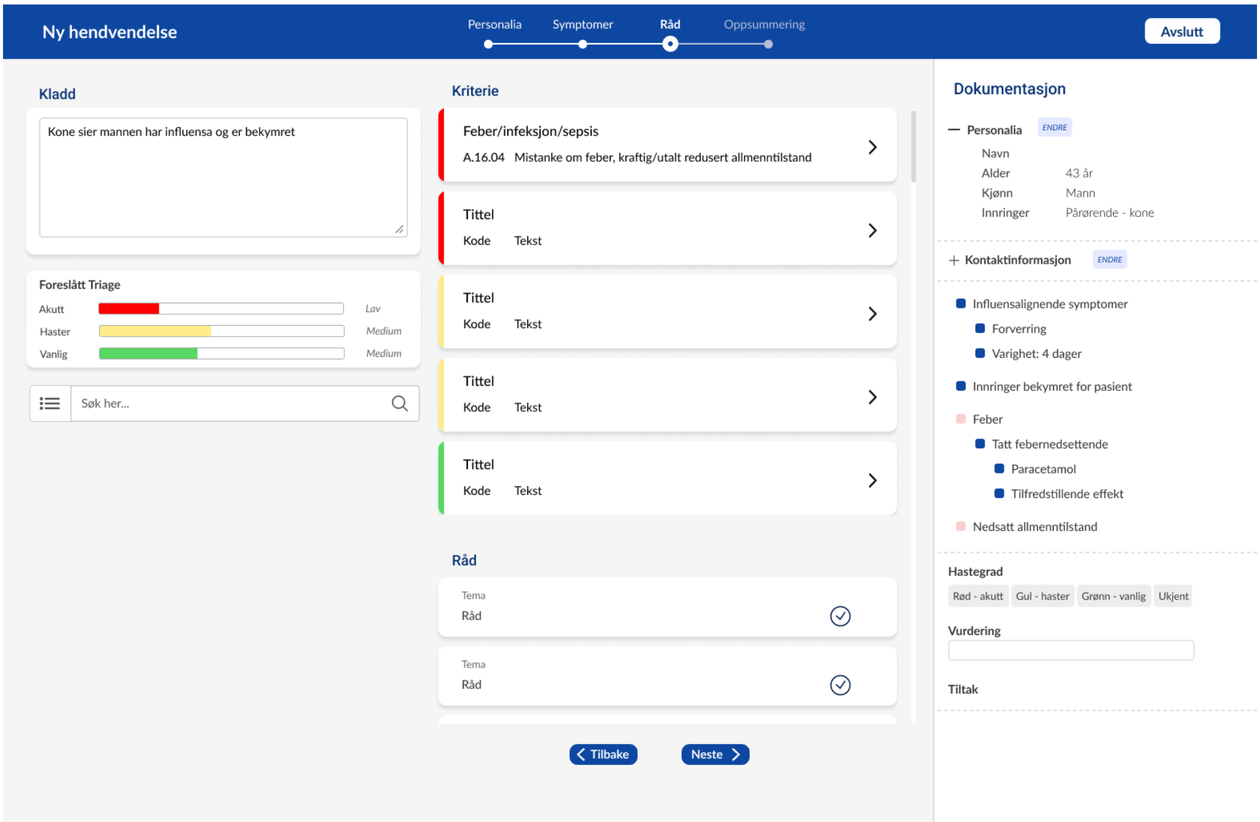

Figure 6.7: Final prototype, Advice

Chapter 7

Discussion

This thesis aimed to answer the following research questions:

RQ1: *How can we design for supporting telephone triage with AI-based suggestions and semi-structured documentation?*

RQ2: *How can a triage tool facilitate the use of natural language in the process of creating semi-structured documentation?*

The aim of this thesis was to explore and investigate how we can design a tool meant to support the nurses working as operators during telephone triage. Specifically, explore how we can design when incorporating AI and support the nurse-AI collaboration. First, a literature review was conducted to understand relevant topics within the research scope. This was done to understand the current state of telephone triage in Norway and get an overview of the challenges and opportunities associated with triage tools, clinical documentation, and AI in healthcare. Secondly, a design process consisting of four phases was done to gather insights, set requirements, and develop prototypes. The findings from the preceding chapters resulted in a high-fidelity prototype. The prototype is intended to support the nurses in the initial phase of the conversation by allowing the nurses to write down the information the patient presents easily. It proposes a way to use this information to give suggestions of symptoms corresponding to the text. In addition, the prototype proposes a way to design the suggested symptoms by the AI, to support the assessment of the patient. Lastly, it explored how we can visualize predicted triage levels by the system to support the nurses when deciding on a triage level.

This chapter provides a discussion of the relevant topics. A brief discussion about the prototypes and user involvement will be presented. The research questions presented above will be answered in the light of the outcome of the project and lastly, the limitations of this thesis will be discussed.

7.1 Human-AI Collaboration in Decision-Making

As AI systems are increasingly recognized as a precious tool for improving decision-making, they propose a possibility to improve the practices of performing triage (*Rever-*

beri et al., 2022). Human-AI collaboration recognizes that both Artificial Intelligence and humans have unique capabilities that have the potential to complement each other. (*Reverberi et al.*, 2022) describes that this collaboration can result in a *"hybrid intelligence"* that could deliver outcomes superior to those achieved by one mind alone.

In the domain of healthcare, humans possess clinical expertise that allows them to use their experience, intuition, and medical knowledge to perform assessments and make decisions. Additionally, humans exhibit an emotional intelligence that is essential in the nursing process. They can provide emotional support and understand nuanced concerns and the emotions of the patients. One of the challenges with telephone triage is that the nurses are restricted to only using auditory cues. Active listening is, therefore, a critical nursing skill. It involves facilitating the conversation and attentively listening to both verbal and non-verbal cues to understand the patient and the problems they present (*Purc-Stephenson and Thrasher*, 2010). During the evaluation, the nurses emphasized that these factors were important in the triage process. The nurses spent time reassuring patients, letting them know that they were there to listen, understand and provide advice and information about their health concerns. Emotional support carries great value in healthcare interactions, including triage. The patients are vulnerable and could be anxious, scared, or uncertain about their health condition. Establishing trust by reassuring the patients that they are there to help can create an environment where patients feel heard, respected, and supported.

On the other hand, Artificial Intelligence has the capability to analyze large volumes of data, identify patterns and provide data-driven insights in the decision-making process (*Lai et al.*, 2021). However, relying solely on AI, and making autonomous systems are dangerous and unethical, especially in high-stake contexts such as medical triage (*Lee et al.*, 2021). A possible solution can therefore be to use the strengths of both humans and AI in the process of making good decisions.

The combination of clinical expertise and emotional intelligence in healthcare professionals, along with the analytical capabilities of AI, can offer a new approach to performing triage compared to the current systems currently used in Norway. However, it is important to balance the AI involvement, to ensure that the human-centric aspect of care will remain.

7.2 Designing to Support Telephone Triage

The purpose of this project was to explore how we can design for this collaboration to support the nurses during telephone triage. There is limited research with a focus on how we can design to support human-AI collaboration. To address this issue, this thesis sought to explore and investigate a possible way to design for this interaction.

A central part when utilizing a system that supports the users in real-time and takes patient-specific information is to translate the information in a way that the system can interpret. The prototype proposed in this project utilizes the same set of ontologies used in RE-AIMED. However, it does not directly use the corpus of ontologies and algorithms for the suggestions. The suggested symptoms were therefore manually implemented in the prototype based on the suggestions in the RE-AIMED prototype. Therefore, the question of whether the suggestions were good or accurate was not the focus of this project, but rather how we can design for this type of interaction. The prototype proposes a possibility of how nurses can use the ease of natural language and still create semi-structured documentation.

There have been other proposed strategies to transform natural language into structural documentation. However, using natural language processing and artificial intelligence might also include biases (*Hashir and Sawhney*, 2020). It can therefore be challenging to rely solely on these technologies to translate human written information to a language the systems understand. The prototype was, therefore, designed to allow the nurses to have the last say when translating the text into ontologies. This was done by suggesting symptoms below the text to capture the symptoms in a structured way. The text that results in a suggested structured symptom is underlined. Another possibility to capture ontologies and create semi-structured notes is using autocompletion (*Murray et al.*, 2021). The benefit of this technique is that it allows the nurses to connect the text directly to an ontology while writing. It could therefore be a strategy to capture the ontologies while minimally interrupting the workflow (*Murray et al.*, 2021). The method used in the prototype shows a post-recognition of the symptoms. However, it could be beneficial to also allow for autocompletion to further support the workflow and reduce the interruption of the workflow.

The operators from the user evaluation highlighted the importance of not presenting too many suggestions and emphasized that the suggested symptoms should be of relevance. While this also includes the level of accuracy of the suggestions, it also relates to the design and layout of the interface. Similar to the RE-AIMED prototype, the list of suggestions includes eight questions to ask. In hindsight, this choice should perhaps have been made with a bit more consideration. An alternative could be to reduce the suggestions. The telephone operators are in a demanding situation and have to handle multiple tasks at once (*Berge et al.*, 2023), it is therefore important to be considerate and not present too much information. Displaying too much makes it difficult to absorb the information and may lead to the nurses ignoring the suggestions (*Reverberi et al.*, 2022). Design principles were used when designing the layout of the list. By grouping each suggestion the users can more easily differentiate the different suggestions. Additionally, more important symptoms to ask the patients will be marked with red or pink making them more visible than the rest of the suggestions.

The operators expressed that the triage tool they are currently utilizing could be very vague in terms of the wording in the discriminators. They said that they could always find a discriminator that could indicate that it was a red case. Therefore, their expertise and experience were required when triaging the patients. This suggests that the tool may not be used when selecting the triage level but rather for documentation purposes which was also supported by (*Holmström*, 2007). However, it was said that it could be helpful to get reassurance that they were on the right track when landing on a decision. In addition, the participants also mentioned that it could be beneficial that the system suggests different discriminators based on the documentation. The prototype in this thesis proposes a way we can design to support the nurses in the decision-making process. Rather than suggesting a triage level, the system could show the likelihood of the different levels as well as suggest fitting discriminators. In the prototype, a list of matching discriminators is presented. These are ranked by urgency so the nurses can first see the most urgent matches.

Getting suggestions on what advice to give could also be helpful. Symptom checkers for patients include similar functions (*Semigran et al.*, 2015). While many of these are designed for patients, the feedback from the nurses suggested that these include functions that would also be beneficial for nurse-led triage.

7.3 Supporting Documentation

During this project, three ways to gather information were identified. Although all these provide information and a better understanding of the patient's situation, the information is presented differently, and the system should therefore be flexible to support all these types. These are further referred to as patient-initiated, nurse-initiated, and system-initiated ways to gather information about the situation.

At the beginning of the conversation, the patients often present and explain their reason for calling (*Hewitt et al.*, 2010). This information is used as a starting point when further understanding the situation in the assessment. From the first sketches of the prototype, the idea was to support this type of information collected through a note field that was later renamed *"draft"*. The purpose of this field was to provide a placeholder for the users to write down the initial information presented by the patient to get an overview of the situation. Additionally, the aim was also to use this information to *"kick start"* the system suggestions. From the evaluation with the nurses, it was learned that some nurses already do this technique using pen and paper. They often wrote down keywords when the patient presented their problem to get an overview, remember what had been said, and prioritize the problems. The nurses were positive to continue using this technique and have the potential to utilize these initial notes in the process further. While the main concern for calling is often presented at the beginning of the conversation, *Morgan and Muskett* (2020) found that this information also could be explained later in the assessment. *Hewitt et al.* (2010) also found that the patients were more likely to bring up additional concerns independently. This highlights the importance of enabling the nurses to easily document patient-initiated information throughout the entire conversation and assessment rather than just the beginning.

The nurse-initiated question here refers to questions that the nurses ask and are not suggested by the system. From the evaluation, the participants said the nurses already knew what questions to ask in familiar situations. They, therefore, felt that it would be time-consuming to try to locate these questions using a search and the list of suggested symptoms. This can make it hard to actively listen to the caller at the same time as well as forgetting to document information. It could also affect the conversation negatively by having to explain why it takes time for the caller. Therefore, designing and facilitating easy documentation of the nurse-initiated questions is crucial. This can help the nurses maintain their clinical autonomy and effectively utilize their expertise. This design consideration is essential because rigid CDSS have been shown to limit clinical autonomy and make the nurses feel passive, thus forgetting important questions to ask (*Ernesäter et al.*, 2009). Not considering this aspect can lead to another challenge, over-reliance on the system, which is one of the pitfalls of human-AI collaboration (*Reverberi et al.*, 2022). The prototype in this thesis seeks to support this type of documentation through the *"draft"* field, where the nurses can write down the answers given by the patient.

System-initiated questions refer to the process when the system suggests questions to ask, which the nurses utilize. As explained previously, the prototype displays a list of suggestions, including symptoms or questions to ask the patient. These are continuously updated based on the current state of the documentation. The response to these suggestions was good; it could serve as a reminder to ask important and relevant questions. It could also save time then the nurses could easily confirm or disconfirm the symptom. However, for some symptom questions, the nurses felt that these required additional explanation and that it would not be sufficient only to click confirm or disconfirm. To achieve this, the participants suggested two ways this documentation process could be improved. Firstly, the participants wanted to be able to write in free text to explain further why it was selected. Secondly, it could be beneficial to have some additional alternatives that they could easily click on.

The note where the nurses write down information was initially meant to support the beginning of the conversation and was not intended to be a part of the documentation but rather a tool for creating structured documentation. While the participants in this study were positive about utilizing this field in the triage process, they also expressed that it would be beneficial that this text was a part of the documentation. They expressed that it could be used to show how the nurses thought of and handled the situation.

7.4 Prototype Development

The prototype was designed and developed through four design iterations. The use of low- mid- and high-fidelity prototypes was useful in explaining the ideas to others. These prototypes were also central to receiving feedback on ideas and different designs. This project presented four phases of the design process, each resulting in an improved prototype. Although the design process was divided into these phases, the process also included smaller iterations in between. This was to explore different ideas and designs on smaller functions within the prototype and get feedback and input from supervisors and other peers. These smaller iterations were helpful in maintaining progress in the design and getting insights into how others perceived different design elements.

The RE-AIMED prototype was used as a starting point in the development of the prototype in this project. The insights gained through the existing prototype and the team members served as an important role in the design process. However, using this as a starting point might also put unintended and unconscious limitations and restrictions to the process, by limiting the exploration of totally different solutions to solve the same issue. On the other hand, understanding issues and opportunities of already functional prototypes is also important to explore how to solve problems in a new way.

7.5 User Evaluation

In the fourth phase of the design process, interviews and evaluations were conducted with telephone operators working at the LEMC. This was done further to understand the workflow and challenges in this field and also to evaluate the current prototype. The findings from this served an important role when making further changes in the prototype. As mentioned before, two scenarios were chosen for the nurses to interact with the prototype. The prototype was made semi-interactable to fit in the context of these. The main objective for doing this was to allow them to experience how the prototype was intended to work actively. Using these scenarios also allowed for a semi-interactive prototype that was possible to make with the prototyping tools used in this project compared to a fully functional system. Another possibility to engage the users could be to showcase the different pages and explain how it was intended to be used. However, it was decided that allowing them to directly engage with the prototype could be more valuable. However, this decision required additional time to prepare the prototype for the evaluation. While the scenarios were intended to imitate a patient-operator conversation, they were also used to aid and prompt the nurses when using the prototype. As a result, the evaluation did not fully capture how it would be used by the nurses in a real or natural patient-operator conversation.

7.6 Answering Research Questions

R1: *How can we design for supporting telephone triage with AI-based suggestions and semi-structured documentation?*

When designing a tool to support the nurses during telephone triage, it is crucial to involve potential users in the process. Understanding the users' needs, preferences, and pain points is essential when designing a tool to support the process. Additionally, it is important to get an understanding of the workflow. By understanding the workflow and the different phases telephone triage consists of, one can identify areas for improvement and explore other solutions. While literature can provide an initial understanding of the workflow, telephone triage itself, and challenges associated with telephone triage, it is vital to engage with and include primary users - telephone triage operators - to understand better how the process actually works. Through direct interaction with users, we can gain valuable insights that can be used when creating a tool to match their workflow and meet their needs.

Telephone triage itself is a challenging process due to its time sensitivity and the need for accurate decision-making. In addition, the nurses already have to handle a wide range of tools, all aiming to support the triage process. It is, therefore, important to emphasize that a tool created to assist triage can't be another stand-alone system but, instead, fully integrated with the triage process.

Integration of artificial intelligence can support the nurses by suggesting questions to ask the patient. This can help the nurses ask important questions and recognize symptom patterns that indicate a high level of triage urgency. However, it is crucial to consider the relevance of suggested symptoms and the number of questions presented to nurses. Presenting too many symptom questions can be overwhelming and lead to information overload, which can cause nurses to ignore the suggestions and result in under-reliance on AI suggestions. Other design considerations for AI-based suggestions include ensuring that suggested descriptive symptom questions clearly show which symptom it describes. If the symptoms are ordered hierarchically, it is important to facilitate easy navigation up and down, allowing nurses to explore related symptoms.

AI technology can also be utilized in the decision-making process of triage. The findings of this thesis suggest that nurses have a positive attitude toward receiving assistance in decision-making. However, it is important to emphasize that the nurses should be the ones to make the final decision. The system should, therefore, not be too rigid when suggesting a triage level. Instead, it can provide guidance by suggesting the likelihood of the different triage levels. Furthermore, the system could offer explanations for the suggested triage levels by proposing appropriate discriminators based on the documented symptoms. However, it is important not to restrict nurses to only selecting from the suggested discriminators. Nurses should have the freedom to choose, and therefore, the system should allow them to view the entire list of discriminators.

Confirming or disconfirming the suggested symptoms can create structured documentation. This form of documentation allows the system to interpret the response and update its suggestions easily. This method for documenting can be sufficient for simpler symptoms. However, some symptoms may need further explanation of the response from the patient than just clicking confirm or disconfirm. It is, therefore, essential to allow the nurses to easily add a description or reason for why certain symptoms were confirmed or disconfirmed. This will create semi-structured documentation that enables the system to interpret the response and not restrict the nurses to reduce the response to only confirm or disconfirm.

R2: *How can a triage tool facilitate the use of natural language in the process of creating semi-structured documentation?*

The literature indicates that healthcare professionals prefer to write documentation in a natural language. It can enable them to capture the complexity of situations and express themselves more intuitively, similar to how they communicate with patients. In addition, allowing the nurses to write in natural language can better facilitate patient-initiated information and responses to nurse-initiated questions. It is, therefore, important to facilitate the use of natural language in telephone triage.

To enable nurses to document information using natural language throughout the triage process, a placeholder can be provided for them to write down relevant details freely. However, for real-time support, this information needs to be transformed into ontologies or other means of structure. To prevent biases in the system's interpretation of the text, the nurses can take an active role in the process of structuring the information. This can be done through post-recognition of the text, where the system suggests symptoms based on the text. Nurses can then directly confirm, disconfirm, or dismiss these suggested symptoms that are presented below. To enhance visibility, the system can underline the words or phrases that trigger symptom suggestions, indicating that a corresponding ontology is suggested. It is also important to show the relation between the text that results in a suggested symptom and the suggested symptom.

Another method for capturing structure in natural language during the creation of semi-structured documentation is through the use of auto-completion. This feature enables nurses to have the final say in transforming the text into ontologies, similar to post-recognition. Furthermore, it can be less disruptive to the workflow, as the text structuring occurs concurrently with the writing process (*Murray et al.*, 2021).

7.7 Limitations

This thesis has provided a description of the process, the requirements established, and the finished prototype. The prototype was created in Figma, which means that the final artifact is still a prototype with limited interaction possibilities and not a fully developed system. The prototyping tool Figma made it possible to make the prototype interactive in terms of navigating between pages, but it did put some limitations when testing and explaining how it was indented to be used. A central part of this prototype was to explore how we can allow the nurses to use the ease of natural language while still creating structured documentation and get suggestions on what to ask next. Because of the limitations of the prototyping tools, it was not possible to input writing directly from the users. An example text on what to write was, therefore, manually written in the prototype. Although it might be sufficient to understand how the interaction was intended, it did not reflect the writing style and how the nurses would write down this information. Additionally, the prototype has not been usability tested.

Triage operators have been involved in the whole process, both through the researchers at RE-AIMED and in the evaluation of the prototype. In total, this only consisted of five telephone operators. While this served as insights into the telephone triage and the workflow that was essential for the design process, the small sample size could potentially impact the generalizability of the findings. If the prototype was further developed, it would therefore be beneficial to include more potential users.

7.8 Chapter Summary

In this chapter, the findings from the literature review and the design process were discussed. Furthermore, it adressed the research questions, followed by a presentation of the limitations of this study.

Chapter 8

Conclusions and Future Work

This thesis aimed to explore how we could design to support nurses in telephone triage and design for nurse-AI collaboration. More specifically, this thesis addressed how we can design for AI-based suggestions and how we can facilitate the use of natural language in the process of creating semi-structured documentation.

This study began by reviewing existing literature on relevant topics within the domain of telephone triage. Then the prototype was developed through four design iterations. The second iteration of the prototype was evaluated by the RE-AIMED team in a design critique. The prototype's third iteration was semi-interactive and evaluated with telephone operations. The feedback received from these evaluations served a dual purpose. Firstly, it identified specific requirements to improve the prototype further. Secondly, it provided insights into the research questions explored in this thesis.

This thesis has contributed with a prototype intending to support the nurses in the triage phases: collecting initial information (personal data and problem formulation), exploring symptoms, selecting the triage level, and giving advice. The prototype utilized the AI-generated suggestions from the RE-AIMED as *"AI-based"* suggestions. Additionally, the prototype included a field intended to support the nurses in remembering what had been said and creating semi-structured documentation.

The findings from the evaluation conducted with telephone operators provided valuable insights and factors to consider when aiming to create a successful nurse-AI collaboration. The participants in the evaluation were optimistic that they could get help to identify important questions to ask the caller and that this could be a convenient way to document some symptoms. However, they highlighted the importance of the system facilitating easy documentation using natural language. For experienced operators, or in common situations, the operators often knew by heart what questions to ask the patient. Therefore, it is necessary to design for fast documentation of nurse-initiated questions and patient-initiated information. The prototype seeks to facilitate this method of documentation through a field where the nurses can write in free text. It proposes a way to design when transforming this information into structured documentation using a post-recognition technique. Additionally, the nurses expressed that just confirming or disconfirming symptoms could be especially difficult for vague symptoms. The AI-based suggestions should also allow the nurses to explain the given answer in free text.

The participants also expressed the importance of having accurate or meaningful suggestions. In addition, it is important to consider the number of suggestions for the nurses. Although we want to suggest symptoms that allow the nurses to decide on their own what questions to ask, it is important to recognize that presenting too much information can make the nurses under-utilize the capabilities of the AI.

A system intended to support telephone triage should also support the nurses in the decision-making process. Although clinical decision support tools have been shown to be an aid in the assessment and for documentation purposes, the system should support the nurses when making the decision. This can be done by utilizing the semi-structured documentation to suggest fitting discriminators from, for example, NIMN. However, it is crucial to facilitate the nurses' reasoning and decision-making abilities and thus not restrict the nurses to only utilize the suggested discriminators.

8.1 Future Work

As previously noted, the prototype presented in this thesis has yet to be usability tested. Additionally, the limitations of the prototyping tool used in this thesis made it impossible for users to type in the documentation freely. This puts restrictions on testing how well this interaction of writing down notes in free text and getting suggestions on the text could work. It would therefore be necessary to test further how telephone operators perceive this interaction and method for creating structured documentation. One could utilize a wizard-of-oz technique to test and get feedback on this type of interaction. This could also allow testing of the system using a conversation that resembles a caller-operator conversation better than what was used in this thesis.

Another aspect worth exploring further is the visualization of the documentation. Whether it should be represented as a vertical list, as illustrated in this prototype, or if there are more effective ways to display the documentation.

The evaluation with telephone operators highlighted that the process of gathering information from callers was time-consuming. It was suggested that callers be informed to have their relevant information ready while on hold. Additionally, it would be worth investigating the potential use of symptom checkers or similar technologies for callers during the waiting period.

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Appendix A Consent Form

Vil du delta i forskningsprosjektet

«Brukervennlig dokumentasjon og beslutningsstøtte under telefontriage»?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å undersøke hvordan vi kan designe et beslutningsverktøy for telefontriage i sanntid. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
Formålet med prosjektet er å undersøke hvordan beslutningsverktøyet som bruker kunstig intelligens kan designes og hvilke funksjoner den bør ha for å passe inn i arbeidsflyten. Dette er en del av datainnsamlingen for en mastergrad i informasjonsvitenskap.

Hvem er ansvarlig for forskningsprosjektet?
Institutt for informasjon- og medievitenskap er ansvarlig for prosjektet.
Prosjektet er et samarbeid mellom institutt for informasjon- og medievitenskap og forskningsprosjektet RE-AIMED fra NORCE. Masteroppgaven skrives av Sandra Erica Søfteland med Frode Guribye som hovedveileder og Arngeir Berge som medveileder og representant fra RE-AIMED.

Hvorfor får du spørsmål om å delta?
Du har fått spørsmål om å delta i forskningsprosjektet da du har erfaring fra telefonsentralen på legevakt og har meldt din interesse for prosjektet.

Hva innebærer det for deg å delta?
Hvis du velger å delta i prosjektet, innebærer det at du deltar på en økt bestående av intervju og evaluering av en prototype. Intervjuet vil gi innsikt i arbeidet som telefonoperatør og aktuelle problemstillinger. Deretter vil du delta i en evaluering av en prototype, hvor du vil ta i bruk prototypen til noen caser. Til slutt vil du få noen oppfølgnings spørsmål knyttet mot prototypen. Det vil bli tatt lydopptak og skrevet notater underveis. Dataen vil bli lagret elektronisk.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Sandra Søfteland (master), Frode Guribye (veileder) og Arngeir Berge (veileder, Phd Cand) vil ha tilgang til dataene gjennom prosjektet.
- Data vil anonymiseres ved transkribering.

Deltakere vil ikke kunne identifiseres ved publisering.

Hva skjer med personopplysningene dine når forskningsprosjektet avsluttes?
Prosjektet skal etter planen avsluttes 01.06.23 eller når oppgaven godkjennes. Datamaterialet med dine personopplysninger vil anonymiseres og ved prosjektslutt vil kun anonymisert informasjon lagres.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
- å få rettet opplysninger om deg som er feil eller misvisende
- å få slettet personopplysninger om deg
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

- Institutt for informasjons- og medievitenskap ved Sandra Erica Søfteland, 95489725, heq011@uib.no eller Frode Guribye, Frode.Guribye@uib.no
- Vårt personvernombud, Janecke Helene Veim, personvernombud@uib.no

Med vennlig hilsen

Frode Guribye   Sandra Erica Søfteland

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Brukervennlig dokumentasjon og beslutningstøtte under telefontriage*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

☐ å delta i intervju
☐ å delta i brukertesting

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

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(Signert av prosjektdeltaker, dato)

Appendix B Interview Guide

Intervju guide

Intervjuet og brukertestingen holdes for å få bedre innsikt i triage prosessen og for å evaluere en prototype.

Gjennom intervjuet vil det bli tatt lydopptak og notater.

Mål

- Få bedre forståelse av triage prosessen
- Få tilbakemeldinger på prototype.
    - Hvilke tanker har brukerne om å bruke fritekst som et verktøy fremfor den ferdige dokumentasjonen.
    - Hvilke tanker brukerne har om at systemet blir en stegvis prosess.
    - Er det noe de mangler?

Overordnet plan

1. *Introduksjon:* Fortelle hva masteroppgaven handler om og formidle hvorfor jeg gjennomfører denne workshopen
2. *Oppvarmingsspørsmål:* Brukes som en introduksjon til oppgavene og samtidig gi bedre forståelse av hvordan triage prosessen er
3. *Introduksjon til prototypen*
4. *Gjennomføring av oppgaver*: Deltakerne skal bruke/teste prototypen ved hjelp av caser.
5. *Evaluering og spørsmål*: Knyttet til prototypen

«Oppvarmings spørsmål»

1. Hvilen erfaring har du som telefonoperatør?
2. Hvilke beslutningsstøtteverktøy bruker du?
3. Er det noe spesielt du liker/ikke liker med dem?
4. Kan du beskrive en typisk samtale?
5. Hvilke deler består en typisk samtale av?

   Be deltaker om å skrive ned delene samtalen består av på post-it lapp
6. Er det noen utfordringer knyttet til stegene?

Kasuistikker

Jente 19 år ringer. Stukket av veps like over øyet for ca 1 time siden. Hele øyelokket er svært hovent, rødt og ømt. Prøvd å lindre ubehaget med en kald klut. Er ikke allergisk. Har ingen andre symptomer.	[Personalia] - Hei, jeg er en jente på 19 år og jeg har fått et vepsestikk over øyet for en liten stund siden, en time siden. [Symptomer] - Og jeg har fått en slags reaksjon rundt stikket. Det er ganske hovent, det er rødt og det er ømt. Jeg vet ikke helt hva jeg skal gjøre, men jeg holder en kald klut over bare for å lindre det litt. Jeg tror ikke jeg er allergisk, eller det er ihvertfall ikke noe kjent allergi.
Kone ringer om sin mann på 43 år. Sier mannen har influensa og hun er bekymret. Han har feber og tar Paracet jevnlig. Febernedsettende har god effekt, men feber kommer tilbake. Han har vært syk i fire dager og konen føler han blir verre. Har ikke spist og har drukket lite.	[Personalia] – Hei, jeg ringer for mannen min som er 43 år. Han har influensa og jeg er ganske bekymret [Symptomer] – Han har feber. - Jeg føler han blir verre, og han har vært syk i fire dager nå - Og han har tatt Paracet og da har egentlig feberen gått ned

Spørsmål knyttet til prototype

1. Hva synes du om å bruke prototypen?
    a. Var det noe du likte?
    b. Var det noe du ikke likte? Hva?
    c. Var det noe du skulle ønske var annerledes?
2. Er det noe du tenker kan være problematisk eller utfordrende ved en slik løsning?
3. Hva synes du om å bruke fritekst i denne sammenhengen?
4. Hva synes du om å ha prosessen steg for steg?
    a. Er det noen utfordringer knyttet mot dette?
5. Var det noe du synes var vanskelig eller vanskelig å forstå?
6. Er det noe du føler mangler? Eller som du ønsker å ha med?
7. *Gå igjennom skjermbilder*
    a. *Personalia*
    b. *Hovedskjerm*
    c. *Symptombeskrivelse/lokasjon*
    d. *Tiltak*
    e. *Oppsummering*

Appendix C Heuristics

1. **Visibility of system status**
   The system should provide appropriate feedback within a reasonable time to keep the users informed of what is going on.

2. **Match between system and the real world**
   The system should use a language and terminology that is familiar to the user. It should follow a real-world convention and present information naturally and logically.

3. **User control and freedom**
   Users can make mistakes and will need a marked emergency exit to leave the unwanted state without prolonged dialog. The system should support undo and redo.

4. **Consistency and standards**
   The system should follow platform conventions to ensure that users do not have to wonder whether different words, situations, or actions have the same meaning.

5. **Error prevention**
   Instead of relying on good error messages, the system should incorporate a careful design that prevents problems from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

6. **Recognition rather than recall**
   The system should minimize the user's memory load by making objects, actions, and options visible. Users should not be required to remember information from one part of the dialog to another. Instructions on how to use the system should be readily accessible and visible when appropriate.

7. **Flexibility and efficiency of use**
   Shortcuts — unseen by the novice user — may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. **Aesthetic and minimalist design**
   The interface should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialog competes with the relevant units of information and diminishes their relative visibility.

9. **Help users recognize, diagnose, and recover from errors**
   Error messages should be expressed in plain language (not codes), precisely indicate the problem, and constructively suggest a solution.

10. **Help and documentation**
    It's best if the system doesn't need any additional explanation. However, it may be necessary to provide documentation to help users understand how to complete their tasks. Information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.