E-health as support to initial responders in rural areas

Improving the care chain in prehospital care

Master's thesis in Master Programme Biomedical Engineering

Johannes Gustafsson, Linnéa Bunse

Department of Electrical Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
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Johannes Gustafsson, Linnéa Bunse

Supervisor: Bengt Arne Sjöqvist and Johanna Bergman, Lindholmen Science Park
Examiner: Bengt Arne Sjöqvist, Electrical Engineering

Master's Thesis 2019Department of Electrical Engineering
Division of Biomedical Engineering
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

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Abstract

Sweden is a geographically large country, with several regions counted as rural areas. Hospitals and emergency care units can be up to one hour away, making emergency healthcare less available in time sensitive situations to some groups of people. To help decrease the waiting time, local people of certain professions, volunteers and similar, have created groups to help with the initial care. In this project these groups are called initial responders.

The aim for the thesis was to develop a demonstrator to help these groups in possibly both medical decision support and to streamline resources sent out from emergency care units. Their needs, and the understanding of the process, were analysed with a literature review and interviews to investigate existing aids and what was missed.

A medical support system was developed, using an interaction design process focused on user experience. The concept allows initial responders to systematically triage a patient and gather valuable information. This information can be transmitted to the emergency care unit to help in their prioritisation and decision of out-sent resources.

Concluding, the medical support system may prove to be beneficial for initial responders in rural areas. Further development and more advanced testing will be needed for future use.

Keywords: e-health, application, prehospital, IVPA, ambulance, rural

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Johannes Gustafsson and Linnéa Bunse, Gothenburg, June 2019

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Glossary

Civil Aviation Administration Luftfartsverket.

Hospital Emergency Center Sjukvårdens Larmcentral.

Medical Decision Support Medicinskt beslutstöd.

Red Cross Frist Aid Röda Korset Första Hjälpen.
Region Västra Götaland Västra Götalandsregionen.

Save the Heart Rädda Hjärtat.
SMS-lifesaver SMS-livräddare.
Swedish Sea Rescue Society Svenska Sjöräddningssällskapet.

The Emergency Services Räddningstjänsten.
The Mountain Rescue Fjällräddningen.
The Rescue Resources Räddningsvärn.
The Swedish Maritime Administration Sjöfartsverket.
Transport Administration Trafikverket.

Voluntary Resource Group Frivilliga resursgrupper.

Waiting for ambulance I väntan på ambulans.

Acronyms

ACS American College of Surgeons.
AMI Acute Myocardinal Infarction.
ATLS Advance Trauma Life Support.
AVPU Alert, Verbals, Pain, Unresponsive.

CDSS Computerized Decision Support System.
CPR Cardiopulmonary resuscitation.

ECG Electrocardiography.
EMS Emergency Medical Services.
ESS Emergency Symptoms and Signs.
ETA Estimated Time of Arrival.

GPS Global Positioning System.

ICAR International Commission for Alpine Rescue.
ICT Information and Communication Technologies.

JRCC Joint Rescue Co-ordination Centre.

MoSCoW Must have, Should have, Could have, Wont have.

PHTLS Prehospital Trauma Life Support.
PVF Primary Ventricular Fibrillation.

RETTS Rapid Emergency Triage and Treatment System.

SALSA Saving Lifes in Stockholm Area.
SATS South African Triage System.
SI Svenskt index för akutmedicinsk larmmottagning.
SMA Swedish Maritime Administration.
SSRS Swedish Sea Rescue Society.
SSS Safety, Situation, Scene.
SvLc Sjukvårdens Larmcentral.

UX User Experience.

VGR Västra Götalandsregionen.
VRG Voluntary Resource Group.

WFA Waiting for Ambulance.

1
Introduction

The introduction chapter is intended to bring up the motive for executing the project. Firstly a brief background to the problem is introduced, followed by a presentation of affected parties. The aims and the limitations are reviewed, and lastly there is a short piece concerning the disposition of the project, to facilitate the reading of the text that follows.

1.1 Background

Sweden consists of many sparsely populated areas, rural areas. These rural areas can be found in the archipelago, in the mountain sides, on the country side, or similar. Large numbers of the first interventions in emergency situations are carried out in connection with an acute medical condition by people with limited medical education and competence. These people are, in this report, named initial responders.

In these areas there is a risk that one ambulance covers a large geographical area. therefore, sending it on an "unnecessary" assignment could make the resource occupied during a long time, unavailable to others in need of care. Similarly, there is a limited number of ambulance helicopters, that additionally have a high operating cost.

A rural area in Sweden can be defined as a place where the inhabitants have between 5-45 minutes travelling time in a car to the closest urban area (more than 3000 inhabitants). Consequently the time of an ambulance's arrival can take up to one hour. In Sweden, rural areas are more frequent in the north and in the middle part of the country, but can be found in the south parts as well. Figure 1.1 displays roughly the distribution of inhabitants in Sweden [3].

The Västra Götaland Regional Council (Västra Götalandsregionen, VGR) is a county council in Sweden responsible for the healthcare in the same district. One of the councils mission is to provide transportation to a hospital in case of need for a patient. VGR has an approximate of eighty available ambulances and one, sometimes two (loaned from a neighbouring district), ambulance helicopters. The ambulance missions are divided into different prioritisation, depending on the acute condition for the patient. There are mainly three prioritisations, 1-3. The most acute degree is called Prio 1 and means that transport is done with blue lights and sirens. Prio 2

includes urgent need for healthcare, however there is no danger to the patients life. Prio 3 requires care for the patient, but is of a less acute nature [4].

An island located north of Gothenburg, in VGR, is an example of a rural area. The island named Åstol is a locality in the south of Tjörn municipality. Year 2010 it had 210 inhabitants and its area reaches to 0.15 km^2. Åstol does not have any connection to the main land, which means that it could take up to 30-40 minutes (or longer) for ambulances to reach the inhabitants using a ferry. For the patients to reach the hospital it could potentially take 2-3 hours depending on the weather [5]. The hospital which is the closest to Åstol is Kungälv sjukhus, which is ca 47 km away by car. The flight distance between Kungälvs sjukhus and Åstol is ca 23 km.

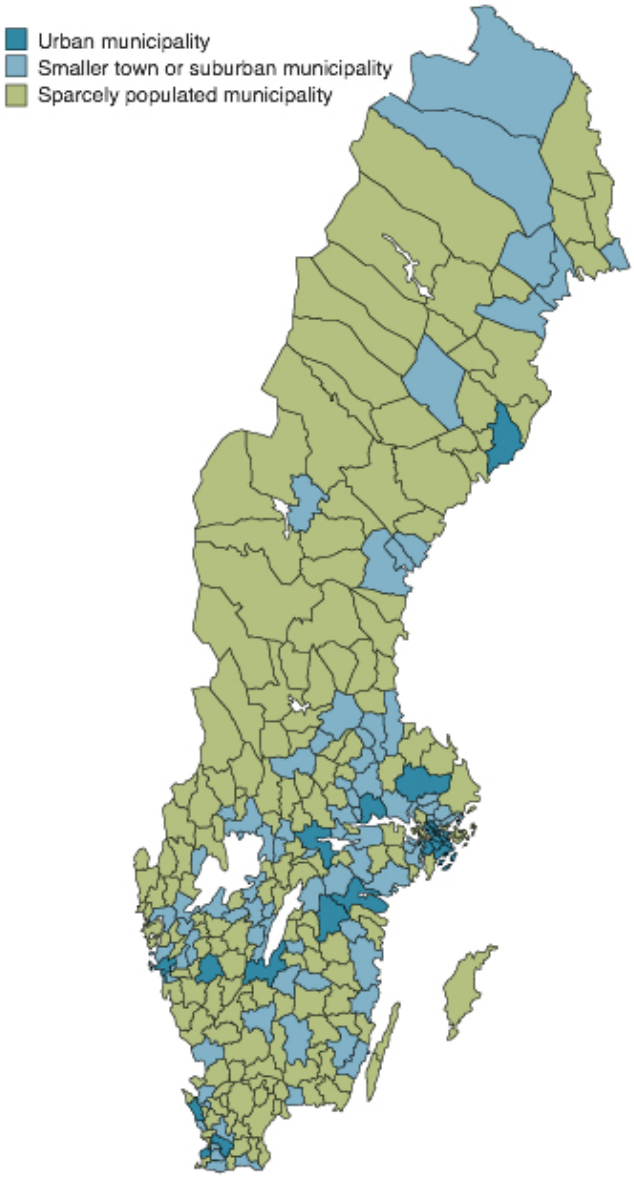


Figure 1.1: A map of Sweden. The different colors represent the distribution of inhabitants in each municipality in the country [1].

With the growing issue of an aging population in the whole country, particularly in sparsely populated areas, together with limited access to local health resources, an increasingly higher demand is put on so-called initial responders.

1.2 Initial Responders

Intial responders are the ones who first arrives to an accident or an emergency situation and represent the first part of a rescue mission. They are also the beginning in the patients healthcare. An example of initial responders are "I väntan på ambulans" - groups (IVPA, waiting for ambulance, in English), Emergency Services and Rescue Resources (räddningsjänst och räddningsvärn), nautical rescue (The Swedish

Maritime Administration) or volunteer organisations such as Swedish Sea Rescue Society and Mountain Rescue (sjöräddningen och fjällräddning). IVPA-groups have through an agreement ensured that they can carry out first aid, provide safety to the patient and keep in touch with the healthcare staff in the ambulance. Initial responders can also include people that are not a part of the rescue system. All groups mentioned above do preliminary judgements and efforts which could be critical for the patient. They are therefore also an important link in the prehospital care [6].

Typical applications could be trauma, suspected heart disease, stroke, allergic reaction or bite from an animal. All these symptoms can be rather time sensitive, hence the initial responders are of crucial importance for the choice of action to be taken. Questions like what kind of emergency transport is necessary and initial care decisions need to be answered. An assessment is that society in the future will increasingly depend on this type of voluntary organisations, and the like, in order to be able to respond effectively to citizens' demands and expectations [7].

With support of modern information and communication technologies (ICT)/e-health, there are great opportunities to create preconditions to support both the initial medical assessment and the choice of appropriate care input.

1.3 Aim

The aim of the project is to produce a demonstrator for an e-health solution adjusted for initial responders. The purpose is to increase the precision in the initial judgment of the patient and together with the Hospital Emergency Center (the medically responsible at SOS alarm, Sjukvårdens Larmcentral, SvLc), assess healthcare and transportation needs.

Objectives:

- Perform a pre-study to map the current e-health solution for initial responders
- Perform an analysis of the needs regarding initial responders as well as for interested parties in the healthcare sector (Västra Götalandsregionen, Sjukvårdens Larmcentral).
- Produce a concept/demonstrator for a complete e-health solution.
- Evaluate the demonstrator together with the intended users.

1.4 Limitations

Given that Sweden is a large country geographically, there are more than a few municipalities located at far distances from hospitals and other emergency centers. Accordingly, many places can be included in the sense of being extreme. Åstol, mentioned above, is a good example of a rural area. Åstol has its own voluntary resource group, which are counted as an IVPA-group, and has spoken out their need for improvement and help in emergency situations. Consequently, Åstol has been

put as one of the main stakeholders for this project. Thereby, the main focus of the project is to meet the need of this IVPA-group.

The second limitations lies with the technology. With the main goal of making a relatively simple helping device, usable for everyone, the project is focused on a mobile platform solution that can handle communication over today's mobile network. The project will concentrate on providing a demonstrator for how a mobile application could work, rather than making an application from scratch to end. The project will be limited to rural areas where it is possible to have a connection to the cloud.

All prototypes along with the final demonstrator are in Swedish.

1.5 Disposition

This thesis is organized into seven different chapters; Introduction, Theory, Methods, Literature Review, Result, Discussion and Conclusion.

The first part, introduction and theory, covers the purpose of the project and some necessary theoretical knowledge used in the remaining part of the thesis. The introduction has the aim to introduce the reader to the current situation, along with some background information and the overall aspiration of the project. The theory chapter introduces theoretical information, processes and theories needed to reach the aims.

Continuing, the chapter concerning methods will bring up the process used throughout the thesis. It is divided into three separate parts; the concept phase, the processing phase and the detailing phase. In the result chapter the outcome from the three phases and the final demonstrator are presented.

Lastly, the results are discussed in the discussion chapter where some of the potential problems are being raised and how the results could be interpreted. Comparison to existing solutions, implementation of the concept and future work is also discussed. Finally the thesis ends with a conclusion.

2
Theory

The theoretical chapter will give a setting for the project. The first part introduces the prehospital care chain, the overall structure and important concepts. Influential laws and regulations, certain degrees of medical trauma education, different working methods and terminology are brought up. The second part handles the chosen design theory with the main activities, included goals and fundamental principles.

2.1 The Prehosptial Care

The Swedish prehospital care includes all medical care, from the moment of the start of an injury or illness, until the right care is given. It is an important part of the care chain and includes many professions along the way. In Västra Götaland Regionen (VGR) the involved parties focused on for this project are;

- Ambulance personnel - paramedics
- Emergency Services - firefighters
- Rescue Services - local emergency services
- Swedish Maritime Administration (SMA) - responsible for all rescue missions at sea
- Swedish Sea Rescue Society (SSRS) - a voluntary group, which offers great help for rescue missions at sea
- Waiting for ambulance (I väntan på ambulans - IVPA) groups
- Other voluntary groups *e.g.* as SMS-livräddare
- Sjukvårdens Larmcentral (SvLc) - medically responsible at SOS alarm

In order to be able to change a process it is important to first understand how it works. Today the care chain starts when the patient, or someone who is close to the patient, calls SOS alarm. SOS will then open a connection with SvLc when they understand that it is a medical situation. SvLc co-listens to the call until they gather enough information and will then take over the conversation. An interview is conducted by the personnel (often an educated nurse) at SvLc and will based on this decide a prioritisation for the patient, after which they send out the necessary resources. These resources can be IVPA-groups or other voluntary groups, an ambulance and an ambulance helicopter (if needed SMA and SSRS are included). They will, however, never only reach out to the IVPA-groups or voluntary groups. The resources leave for the patient and will then decide which hospital to go if needed, depending on the situation. Figure 2.1 gives a graphic view of the prehospital care

chain [8][9].

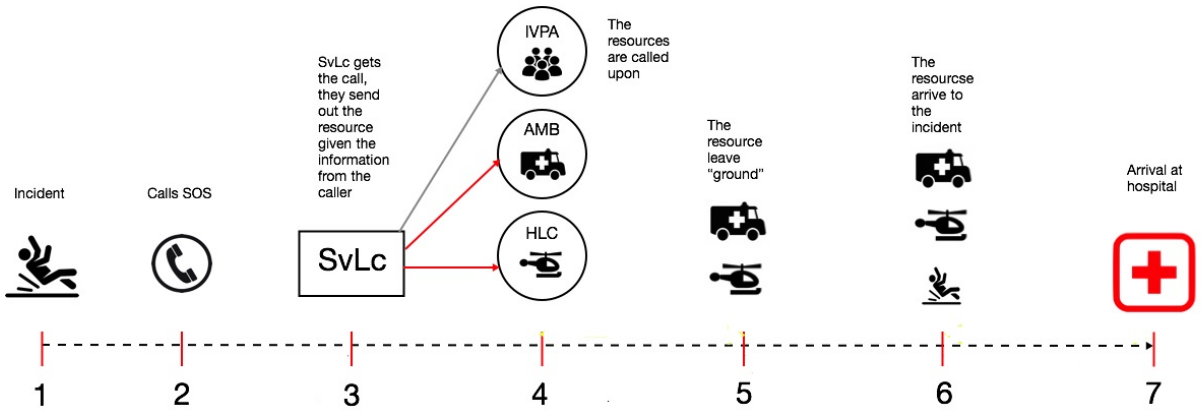


Figure 2.1: The prehospital care chain

2.1.1 E-health

E-health is a concept which includes the use of information and communication technologies (ICT) related to health. It can be used by healthcare professionals, patients or by others who are interested in their health somehow. E-health can *e.g.* include electronic health records, telemedicine services, health information networks, health monitoring, applications related to health and much more [10].

2.1.2 Laws and Regulations

Like in all sectors, there are relevant laws and regulations related to healthcare and initial responders. Here some associated to this thesis are listed. A discussion on the laws and regulations is given in section 6.2

Law (2003:778) Protection Against Accidents
According to §1 in chapter 2, anyone who comes upon an accident, indicating serious danger for this persons health, should if possible, warn the ones in danger and if necessary call for help. Individuals who are at least 18 years old and not older than 65 are obligated to participate in emergency situations to the extents he or she is able to, as stated by §1 in chapter 6. The same section also mentions that a municipality can assign a group of "resource responders". If this is possible the group should consist of volunteers. The members of the group have to participate in exercises of maximum 20 hours yearly [11].

§4 in chapter 7 mentions that those who have participated in a rescue mission, that matches these laws, should be compensated for travel, missed work opportunities as well as damages to clothes or other personal belongings [11].

Regulation (2003: 789) on Protection Against Accidents
Depending on what type of geographical area where a rescue is needed, different

departments are responsible. Table 2.1 shows which department that is held responsible for various areas [12].

Area	**Department**
Mountain rescue	The Police
Rescue at sea	The Swedish Maritime Rescue Administration
Airborne rescue	The Swedish Maritime Rescue Administration

Table 2.1: Table showing which departments are responsible for rescue missions in different areas

Health and Medical Care Law (2017:30)
The health and medical care law considers;

- Actions to medically prevent, investigate and treat diseases and injuries
- Patient transport
- Care of the deceased

The aim is to have a good healthcare on equal conditions for the whole population. The patient that is in the most urgent need for care should also receive it first according to §1 in chapter 3. Good healthcare should according to chapter 5, §1 fulfill the following criteria:

1. High quality and hygienic standard
2. Meet the patient's need of security and continuity
3. Have respect for the patient's autonomy and integrity
4. Have good connections between the patient and the healthcare staff
5. Be easily accessible [13].

Patient Data Law (2008:355)
§4 in chapter 2 mentions a few different reasons where it is allowed to keep patient data;

1. To complete obligations mentioned in chapter 3 and to maintain other documentation needed for care of patients,
2. If it is needed for administration concerning patients and which aims to give care in single cases or which is preceded by care in single cases.
3. If it is used to maintain other documentation which follows laws, regulation or other constitution.
4. If it is needed to systematically and continuously develop and secure the quality in the organisation.
5. If it is needed for administration, planing, follow up, evaluation and supervision of the organisation
6. If it is needed to produce statistics within healthcare [14].

2.1.3 Medical Education Trauma Care

This section aims to differentiate between the various medical educations initial responders might have, the distinctive disciplines are explained below. Figure 2.2 shows how they are more or less related to each other.

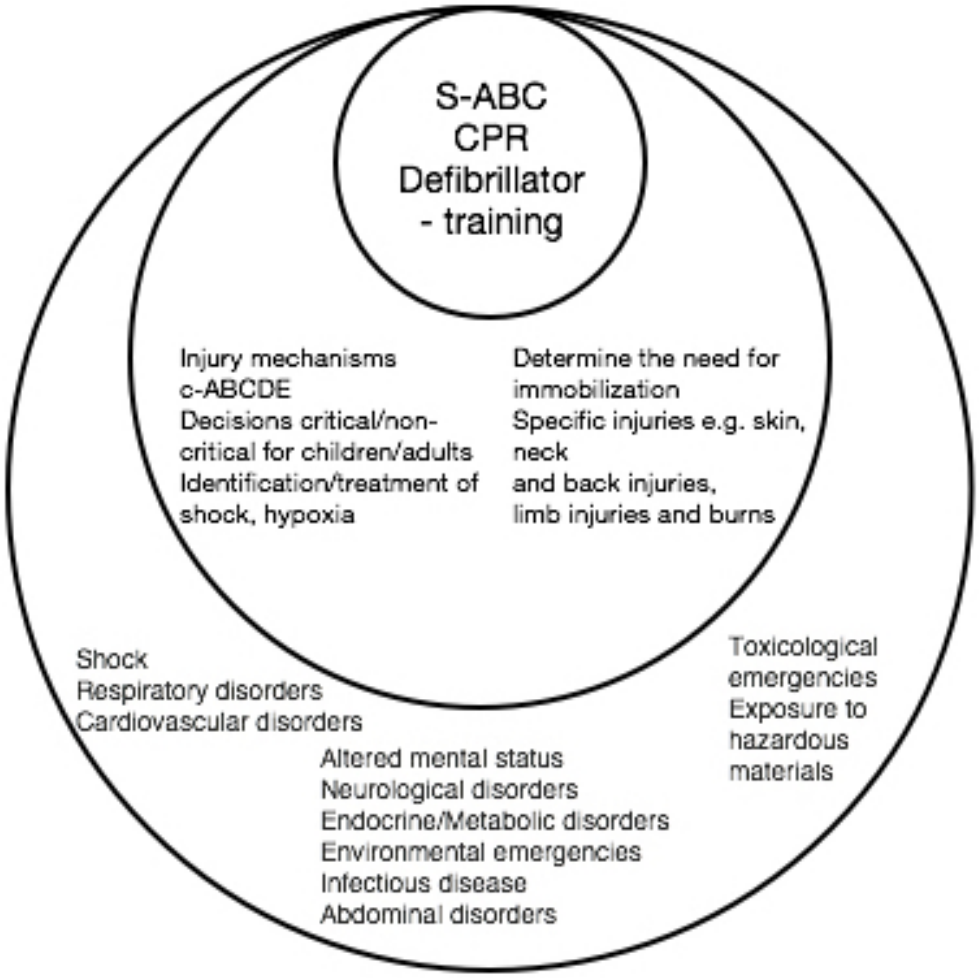


Figure 2.2: The inner circle shows what is taught in first aid, the middle is for PHTLS and the largest includes AMLS knowledge.

Cardiopulmonary resuscitation (CPR)
CPR is performed when a heart stops beating. If CPR is performed early it can double or even triple the chances of survival after a cardiac arrest. The purpose of performing CPR is to keep the blood flowing in the body, which increases the chances for medical personnel to perform successful resuscitation when they arrive. CPR is performed by making compressions to the patients chest, about 5 cm deep and mouth to mouth breaths at a ratio of 30:2 compressions to breaths [15].

Cardiopulmonary resuscitation with a defibrillator
A defibrillator is a medical device, placed in public places in the whole country and is available for everyone in case of a cardiac arrest. The defibrillator is attached to

the chest of the patient with two electrodes and can perform analysis of the state of patient, after which it will decide if an electric shock to the heart is needed or not. If a shock is recommended, a shock will be given as soon as a button is pressed, however, if it is not recommend it will not be possible to initiate a shock. This process repeats itself every two minutes. In between CPR should be given. Most defibrillators have audio instructions for how to be used, some also have descriptive images. If the first defibrillation is given within 3 minutes, then the chances of survival increases with over 70 % [16].

Prehospital Trauma Life Support
The National Association of Emergency Medical Technicians (NAEMT) and The American College of Surgeons (ACS) have through a collaboration formed a concept for Prehospital Trauma Life Support (PHTLS) and is given as a trauma educational training for several professions such as; doctors, nurses, paramedics, firefighters and police. PHTLS derives from the Advanced Trauma Life Support (ATLS) principles founded by ACS, which is taught to people with higher medical educations *e.g.* doctors [17].

PHTLS reaches back to the beginning of the 1980's and is considered a global gold standard. It is found in the principal to encourage critical thinking based on routine based procedures and good knowledge, and with these make qualified decisions when treating a person in trauma with the aim to reduce mortality. The routine follows the so called ABCDE-scheme. Depending on the profession of the carer, the number of letters vary. For the Emergency Services an S for safety is added. Usually a c (c-ABCDE), which stands for Catastrophic Haemorrhage Control, is included. Table 2.2 shows what the abbreviations include [18].

	Meaning	**Action**
S	Safety	Check surroundings to determine safety
c	Catastrophic Haemorrhage Control	Control of the heart and life-threatening bleeding
A	Airway	Create free airway and stabilise the cervical spine
B	Breathing	Control breathing, see, listen and feel
C	Circulation and and Haemorrhage Control	Is there an outer/inner bleeding, check pulse
D	Disability or Neurological Deficit	Control of awareness, sensation and ability to move
E	Extremity/Environment /Exposure	Protect from the environment

Table 2.2: Abbreviations in the ABCDE-procedure

Advance Medical Life Support
The NAEMT are also responsible for the Advance Medical Life Support education (AMLS), which includes professions under Emergency Medical Services (EMS), thus paramedics and hospital staff. The education aims to manage and recognise com-

mon medical crises. AMLS is considered more advanced than PHTLS and includes:

- Respiratory disorders
- Cardiovascular disorders
- Shock
- Altered mental status
- Neurological disorders
- Endocrine/Metabolic disorders
- Environmental emergencies
- Infectious disease
- Abdominal disorders
- Toxicological emergencies
- Exposure to hazardous materials [17]

First Aid
For non-professionals first aid education is commonly taught. First aid consist of CPR, minor condition treatments (cuts and similar) and S-ABC, sometimes D and E are included. ABC is considered a triage system for how to approach an emergency. S is replaced with L in Sweden (livsfarligt läge), and is considered a more basic version of the above educations [19]. Below follows a brief explanation on how to go through each letter;

S - The scene of the accident is controlled. What has happened? Will you be put in danger when helping the patient? Do you need to remove the patient from the scene? If the location is not safe, remove the patient to the extent of which you are able to without putting yourself in danger.

A - Controlling the airways of the patient. Is the patient breathing with difficulties? The aim is to create free airways. The mouth of the patient is checked for any foreign objects. Do you need to perform a jaw-thrust manoeuvre as seen in figure 2.3? If you have to leave the patient alone, then the caretaker should be left in the recovery position (stabilt sidoläge) [20].

B - Examining the breathing. The breathing frequency, oxygen saturation in the blood and possible cyanosis (blue lips) is examined to create an understanding for how well the patient is able to breath. Actions to take includes to help the patient sit up and provide oxygen gas, however, only medically trained staff are allowed to provide oxygen gas [20].

C - The circulation is controlled. External bleedings are firstly investigated on the patient and stopped. Internal bleedings can be measured with the help of checking capillary backfill. This is done by pushing the sternum for 5 seconds, release and then count the seconds it takes before it regains colour. Next, the pulse should be examined, both where it is and its frequency [20].

D - Disability of the patient. A fast and rough system to examine a patients disability is AVPU, which stands for alert, verbal, pain and unresponsive and is noted as below;

- Alert - the patient is fully awake
- Verbal - the patient is not fully awake but can talk
- Pain - the patient is not awake but responds to pain
- Unresponsive - the patient shows no reaction at all [20]

E - The exposure of the patient. Here it is important to keep the temperature of the patient. A full body examination is done to detect any damage or signs of injury [20].

2.1.4 Systematic

Working systematically in a prehospital setting can improve the healthcare for the patient. A study showed that when ambulance staff worked with a computerized decision support system (CDSS) the compliance with prehospital guidelines increased. The ambulance staff performed more assessments and interventions which increases the patients safety. There was also no notable change in time spent on the scene when using the CDSS compared to not using it [21]. A different study testing a CDSS showed that while the compliance increased when using a CDSS, the time spent on the scene increased as well [22].

2.1.5 Triage

Triage systems are used in order to prioritise the urgency for treating patients. The goal is to provide the patient with the greatest need help first. Many of the systems are quite similar in their function and differ almost only by the name. The South African Triage System (SATS) and the Rapid Emergency Triage and Treatment System (RETTS) are two commonly used systems. Table 2.3 shows a comparison between these two.

SATS, derived from South Africa, offers a way to systematically investigate a patient, going through the most urgent indications firstly. The basic idea is to measure the vital signs. SATS is based on "early warning signals" which should provide an indication for the patients medical risk based on a score. SATS does not have any algorithms to deal with symptoms and signs in a structured way. The medical personnel will prioritise the patients based only on vital signs upon arrival [23].

RETTS was developed in Sweden and is aimed to support the user in what to focus on regarding the status of the patient. RETTS gives advice on blood sampling and monitoring during the care process based on the priority level of the patient. RETTS is based on vital signs, emergency signs and symptoms, the patients autonomy and the experience of the caregiver [24].

System	Vital Signs	Symtom Based	Emergency Signs and Symtoms	Recommended Action	Autonomy Algorithm	Priority
SATS	x	x				x
RETTS	x	x	x	x	x	x

Table 2.3: Comparison of two triage systems.

2.1.6 Terminology

Below follows some basic terminology related to the prehospital care used in the report.

Pulse Oximetry - A frequently used non-invasive medical device, utilised to measure the blood oxygen saturation. It provides the opportunity to quickly recognise common health issues such as abnormalities in ventilation [25] and early signs of hypoxemia, *i.e.* low level of oxygen in the blood [26].

Windshield Report - Commonly in emergency situations a so called "windshield report" (vindruterapport) is announced. The report is given by the first arrivals to the emergency, *i.e.* the police, ambulance personnel or the rescue services. The intention of the report is to give an idea of the degree of damage, medically and environmentally [27].

Rakel - A communication network system, with coverage over the whole country. It is designed to be safe and secure and used by organisations essential for the society, *e.g.* ambulances, the Swedish Sea Rescue Society and similar [28].

2.2 Design Theory

To meet the aims of this project, this report will follow an interaction design process. The design process is focused on the intended users, the user experience (UX). There are four key elements in a UX-aimed process, namely;

1. Determine needs and identifying requirements.
2. Process different concepts in the frame of the established requirements.
3. Creating versions of the concepts, possible to interact with.
4. Evaluate each step from the beginning to the end of the development process.

To cover these bases, achieving the key elements, yet another three activities are to be followed

1. Throughout the development of the design project, the users should be involved from the beginning to the end.

2. Usability and user experience goals should be decided upon early on (through empirical measurements).
3. Iteration in these processes is to be used [29].

The interaction design process includes all these mentioned above through three different phases; the concept-, processing- and detailing phase. All these phases are iterative, once one process is completed it is important to go back and analyze the given information or result and to re-evaluate it. You could say that each phase has its own artifact cycle. During the time of a project it is possible that the needs, demands, target group, time frame or similar, develop. Hence, it is important to investigate if any part of a phase is in need of revisiting due to new knowledge [30].

2.2.1 Usability and User Experience

In an interaction design process one often divides the aims into *the usability goals* and *the user experience goals*. The usability goals can be separated into the following criteria:

- Effectiveness - refers to how well a system is performing the task it is supposed to do
- Efficiency - describes how well a system is in supporting its users in executing a task it is designed for
- Safety - includes both minimising the risk of putting the user in direct physical danger and to decrease undesirable situations in the design itself
- Utility - includes how well a system administer the wanted functionality for the user
- Learnability - answers the question on how easy a system is to use
- Memorability - once learned, how easy a system is to remember how to use

The user experience goals are more subjective, hence less clearly defined. How the user interprets the concept or product in a positive manner could be described with words such as enjoyable, fun, helpful, motivating, emotionally fulfilling and similar. It describes how the concept makes the user feel, unlike the more objective usability goals which rather explains how useful the concept might be. It is important to understand that there might be a trade-off between these two goals, and to early on decide which once that are most important. The goals differ depending on the context of the design process, who the users are and the main goal of the product or concept itself [29]. For this thesis, focus lies mainly on accomplishing the usability goals.

2.2.2 The Fundamental Design Principles

In all design projects there are certain design principles. Design in UX is aimed is to reduce the cognitive load on the user in certain smart manners. Depending on the aim of a project, there are different principals to take into consideration. The principles derive from experience, theory-based knowledge and common sense. The

most pervading principals in this project are the following:

The **Affordances** of a system, which means what action the perceived characteristics of an object invites to. The easier it is to understand, the better affordance.

The **visibility** or **discoverability**. Visibility includes both what you can and can not see in a user interface, and will affect the interpretation. Guidelines suggests the utilisation of contours, certain colours and similar will enhance the user experience.

The third principle is called **mapping** and imply the relationship between an object and its function. It is common to take advantage of so called natural mapping such as physical analogies, cultural standards and general biological conditions to support a simple, immediate and unambiguous understanding.

Mental and conceptual models means that our internal representations of reality constructs a mental model, which is translated into a conceptual model within an interference. It is common to use metaphors from our everyday life and translate this into a system, which should facilitate the use of a system.

Feedback is a principal used to give back information to the user about what actions have been taken and what the result has been. *E.g.* specific sounds for specific situations or similar.

To counteract misuse and misunderstandings so called **constrains** are used. Constrains are utilised to not let the user make any mistakes in the interface, hence encouraging to do right.

Lastly, **consistency** is a well known design principle to take into consideration. Consistency includes designing similar elements for similar operations. It will facilitate the learning rate throughout the use [31] [29].

(a) First stand behind the patient.

(b) Place your hands on the jaw.

(c) Lift the jaw up up to create free airways.

Figure 2.3: Steps for performing the jaw-thrust maneuver [2].

3
Methods

This chapter explains the overall methods and terminology used throughout the progress. The project has followed the process of interaction design, a user-centered design method. The aim of this work method is to investigate how an interactive product or service appears in context with the user, when the product or service is in use [30].

3.1 Concept Phase

In the first phase the focus lies on exploring what is desirable among the project's stakeholders. It can be thought of a data collection step in the process. To create a product of value, the needs of the users are identified. Identification of the stakeholders has also been included, in this case; which medical education the initial responder is assumed to have. The demands of Chalmers and Lund University also needs to be fulfilled. In order to reach these insights, data collection was performed in the shape of a literature review and interviews. The result of the data collection is translated into concept ideas, which are valued with regard to the stakeholders. The focus is chosen for the continuation in the project; how the product and service should be designed [30].

3.1.1 Literature Review

The project started with a literature review, or a pre-study, with the aim to acquire a better understanding for the area and to grasp how the process of the prehospital care chain works [30].

3.1.2 Interviews

To apprehend the user-need for the demonstrator several relevant and qualified people were interviewed. They all represent different sections of the prehospital care chain. The interviews were performed in a semi-structured manner, meaning that a set of major inquiries are decided instead of many detailed questions. The queries are a mix of open and closed questions.

A semi-structured interview has the aim to give the interviewed room to control the order in which different subjects come up. The purpose of this is to retrieve the persons's view of their reality, accordingly it is important not to lead the interview

too much [30].

An interview guide was written in advance, where the intent of the interview was clarified along with research on the person to be interviewed. The majority of the interviews were done in person, however due to practical concerns, some were done over the phone or via Skype.

The interviews were later compiled, with the most relevant conclusions for each section in the prehospital care chain. The compilation was performed by dividing the answers into *current problems* (in the prehospital care) and *possible actions* to get around these.

3.1.3 Concept Ideas

When the first phase of collecting data and knowledge is concluded it is important to get a grip on how to advance with the product or service development. An evaluation together with the mentors was held to help in tapering the continuation.

The MoSCoW-model was utilised to build up different concepts from the first phase. The MoSCoW-model is a prioritisation technique for helping to balance and to manage priorities in the concepts. The criteria are divided into four categories; must have, should have, could have and won't have (at this time). Based on this division it is easier to create a common image of what the product or service should include and to get a primary idea of how the concepts will be developed [32].

To compare the concepts relevance in relation to each other a matrix consisting of different demands on one side and the concepts on the other, a so called Pugh-matrix, was created. A Pugh-matrix is helpful in the sense of evaluating which concepts to continue with. It offers a recap, to see if certain goals and limitations are met and will help eliminating possible drawbacks when continuing to the processing phase [30].

3.2 Processing Phase

The process phase is also called the physical design phase. Here, an operative image of the product is outlined. The idea is to develop and determine an overall picture of the main features and system solutions. Several proposals in the concept phase can be combined. When continuing, the idea of the product or service should be more adapted in detail to reality in order for it to work practically, formally and technically. However, in this project the technical part is bounded due to limitations set in the beginning of the project. Several smaller named methods will be used to reach the end of this phase [30].

3.2.1 Personas

A persona is a fictive person constructed from the data collection phase. Personas are used to create more empathy whilst commencing the design process and to increase remembering the needs and demands put on the product or design. A persona is therefore more thought of as a collection of data, rather than a specific individual. It is easier to take a character into consideration in the process of the design, rather than keeping certain demands at mind constantly. There are usually primary personas and secondary personas. The design is always focused on the goals of the primary persona, and the secondary's needs can be taken into consideration, if they are not in conflict with the primary's needs. However, if that would be the case, it can be better to continue with two parallel phases and designs, and later combine these, to not solemnly make one weaker design [30].

As the continuation of the project essentially focused on two concepts, the persons were divided after these two. One group associated with each concept.

3.2.2 Scenarios

To put the personas to life, a scenario-based method is often used. This method is effective as it shapes a possible future situation where the product or concept is to be used, with one, or more, personas as part of the story. Scenarios describe a fictive situation, however reality-based, and include the product or concept from start to end, with the aim to see how people and different situations might affect the interpretation of the product or concept. All these mini-interactions give a great inspiration for further design implementation [30].

In this project two scenarios were constructed. It proved to be a helpful way to determine usage scenarios and include requirements. The scenarios created described different situations when both the concepts were to be used, and personas involved could be integrated.

3.2.3 Low Fidelity Prototype

Design is driven by an iterative process, though drawing sketches and creating prototypes. When creating a prototype the ambition is to firstly create a draft on how the final idea might look. Secondly, and maybe more importantly, it is immensely essential to graphically explain an idea in order to compare and show to the others of the design team. Similarly, user experience and demands are quite difficult to measure if not put down to some sort of existence. Prototypes offers the possibility to evaluate ideas, experience and demands, before making expensive and time consuming decisions into final design, only to find out that energy has been focused wrongly. A low fidelity prototype, lo-fi prototype, is often a sketch of some sort, with low detailing level and no real interactive implementations. High fidelity prototypes are described as interactive computer-based with a high level of detail [30].

The first prototypes constructed were very simple sketches done by hand, which later were further developed into a bit more detailed drawing on a sketch program on the computer, however still quite plain. Here it was more accessible to change order of scenarios, visualise options with colours and chose simple interaction design options.

3.2.4 Evaluation of Low Fidelity Prototype

To fully make sure that the main users and stakeholder agree with the concepts, and to stay close to initial aims and limitations, an evaluation of the prototypes were done. Important parties in the project were asked to step through the concepts in the low fidelity prototypes and to give inputs concerning their experiences.

3.3 Detailing Phase

Lastly, in the detail phase, the concept is to be specified in forms of a high fidelity prototype. Quantitative measurements of the idea was now performed and valued. The detailing phase is like the once above, an iterative phase, where the prototype and measurements will be valued, redone, valued again and so forth. The aim is that the product finally meets the requirements of all the stakeholders [30].

3.3.1 High Fidelity Prototype/Demonstrator

The high fidelity prototype was produced using an online program called *MIT app inventor*. App inventor is "a visual, blocks language for building Android Apps" [33]. The program has previously been used in courses at the University of Chalmers, and was therefore a good alternative when developing the hi-fi prototype.

3.3.2 Evaluation of High Fidelity Prototype/Demonstrator

Similar to the evaluation of the low fidelity prototype, essential users were asked to perform a review of the resulting prototype. A smaller focus group was put together, a group of relevant people to discuss and go trough the wanted concept.

To get a quantitative value on how user friendly the concept seemed, the System Usability Scale (SUS) was utilised. The scale is a questionnaire consisting of ten questions. All questions have the same five options of response, each with a value from 1-5. The five responses and their values can be seen in table 3.1.

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	2	3	4	5

Table 3.1: The five response options and their values below.

The questions in the SUS are:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

The SUS score is calculated differently for odd and even questions. For the odd questions the result is *the value - 1*, for even numbers the result is *5 - the value*. The overall score is the sum of the results for all questions multiplied by *2.5*, hence the scale is converted to a *0 - 100* range of possible values. The average score measured on 500 assessments reaches 68, and can be considered reliable generated from a minimum of two users. A score below 68 is considered below average and all above to be over average [34].

4
Literature Review

In this chapter prerequisites, different interested parties, current status in the subject and other countries initiatives are processed as a first step in understanding the scope of the project.

4.1 Initial Responder in Sweden

Below, several initial responder groups are identified throughout Sweden. They differ slightly in original profession, payment agreements and assumed medical experience. In table 4.1 the differences and similarities are visualised. Even though the main stakeholder for this project has been elected as the resource rescue at Åstol, all the groups below are considered as possible users of the final product.

Waiting for Ambulance
To accommodate people in rural areas, several counties in Sweden have introduced a concept called "waiting for ambulance" - groups (WFA, IVPA in Swedish). In 2006 a total of more than 80 municipalities were reported to have agreements with the county councils to receive support in case of acute illness and accidents. These IVPA-groups are generally a part of the emergency service in Sweden, firefighters, and have in total received 56-62 hours of medical studies (of which 40 hours are included in their basic training). Assumed degree of medical care includes ability to

- Perform first aid
- Provide breath-enhancing measures
- Give artificial respiration
- Give oxygen treatment
- Carry out heart and lung rescue
- Stop bleeding
- Take action in case of burns / hypothermia
- Perform simple measures in various disease states in adults and children
- Perform shock prevention measures
- Fix fractures
- Assist in childbirth
- Give emotional first aid
- Follow the regulations and laws that apply to the above assignments.

The first IVPA-groups were initialised in the beginning of the 1970's, in Gagnef, Dalarna. The concept later expanded to the whole county and other rural counties such as Värmland, Jämtland and Norrbotten [35] [36]. WFA groups are also active in Skåne, hence the concept exists from the far north to the south of Sweden [37].

Saving Lives in Stockholm Area
Another initiative conducted in Sweden is the SALSA project (Saving lives in Stockholm area) that started in 2005 with the main goal to reduce the mortality rate from cardiac arrests. Just like in the IVPA-concept, emergency services in the area will be informed, however, now the objective is to equip as many places as possible with defibrillators and make sure that a certain group of people are educated in CPR. Apart from the rescue services, many public places such as malls, airports and similar, are a part of the project. Certain security companies are educated in CPR and know where the closest defibrillators are situated [38]. Later in the project, taxi companies were included. The cars are directly connected to Södersjukhuset's system and will retrieve an SMS if the car is close by a person in need [39]. Now the police is included in the SALSA project, and the whole project has expanded to the counties Halland and Gotland [40].

Voluntary Resource Groups
Since 2004 municipalities in a large part of Sweden have introduced a group of people called voluntary resource groups (VRG) [41]. By the initiative of each municipality the Swedish Civil Defence Association educates voluntary people, with a certain experience or profession, to be able to handle crisis situations. They are able to help out in case of fire, floods and similar, but are also educated in first aid and CPR, hence the VRG can be counted into initial responders [42].

Semi Professionals
A recent study carried out at the University of Linköping has shown that people within certain professions have the ability to help out in emergency situations. They are called semi-professionals and are educated in first aid and do often have access to a car. Four groups of professions have been identified as good semi-professionals, where their original duties are to be extended amid response and rescue within the framework of their regular occupation. These four groups are home assistance staff, security officers, real estate technicians and administrative personnel in the emergency services [43].

Swedish Sea Rescue Society
The Swedish Sea Rescue Society (SSRS) goes under The Swedish Maritime Administration. They are a nonprofit organisation, with the same expected medical education as the IVPA-groups, and they participate in around 70% of the rescue salvages by sea in Sweden [44].

Resource Rescue
An example of a rather unique group of responders is the group at Åstol, an island with no connection to land, outside of Gothenburg. With less than 200 all year

around inhabitants, the citizens have formed an association with voluntary people of different professions, such as doctors, nurses, home assistance staff, firefighters and similar. Together they form the "Rescue Resources" and are together with the local rescue services the initial responders in the area and are also counted as an IVPA-group [5].

Mountain Rescue
The Mountain Rescue in Sweden is an organisation consisting of around 400 members in 30 different units around the country. The rescuers have received a basic education and annual exercises at the police. They are taught in terrain training, snow and avalanche knowledge, radio communication, first aid and navigation. The police is the official responsible of all rescue missions in the mountains, and they have the Mountain Rescue at a their disposal in case of need. When the mountain rescuers are sent out on assignments, they work under the direction of a rescue leader from the police and an intervention leader from the Mountain Rescue [45].

Name	Occupation	Payment	Education
WFA	Rescue Services	Yes	First Aid or PHTLS
SALSA	Taxi driver, Security officer, Police etc.	Yes	First Aid
VRG	Not specified	Yes, when called upon	First Aid or PHTLS
Semi-Professionals	Real Estate Technicians, Administrative Personnel in the Rescue Services Home assistance staff, Security officers	Yes	First Aid or PHTLS
SSRS	Not specified	Allowances	PHTLS
Rescue Resources	Not specified	No	First Aid or more
Mountain Rescue	Not specified	Not specified	First Aid

Table 4.1: Different groups of initial responders.

4.2 Mobile Applications

There are currently some available applications related to initial responders. Below follows some examples of a few relevant. A comparison between the applications which are used for alerting volunteers is shown in table 4.2. The section is divided into alerting applications and first aid applications.

4.2.1 Applications Used for Alerting Volunteers

ESKORT
ESKORT is a mobile application, designed for volunteer initial responders. It's used on trial in Norrköping muncipality. One of its primary abilities is to receive alerts. Whenever this occurs, the app produces a unique sound as well as sends a push notification. When the alarm is opened, the user is given information concerning the situation and the opportunity to either accept or decline. If the alarm is accepted, the user is asked if help with navigation is desired, and if so, the application automatically starts the Google Maps application. The user can also sign in as well as sign out from the app. The position of the volunteers is not kept at all times, instead it is retrieved at the time of a new alarm. Hence, the integrity of the volunteers is preserved and additionally maintains the battery. Another feature provided by the application is the possibility to track the path of the volunteer emerging to the site of emergency. When the volunteer has reached the destination, he or she can mark him- or herself as arrived [43].

FirstAED
Another application, similar to ESKORT, is FirstAED. It used in Norway with purpose of alerting initial responders and have them be in place within 5 minutes in cases of cardiac arrest. It alerts initial responders with a loud sounding alarm, and provides the following:

- Instructions for the role of the responder
- An overview of positions of other initial responders
- Directions to the emergency location
- The ability to call other initial responders or the emergency medical service via a contact menu [46]

The St John First Responder App
The St John First Responder app, used in some parts of Australia, notifies anyone within the distance of 500 metres to a person who has alerted an ambulance. However some restrictions exists, the incident has to be in the category of a specific kind. This category includes *e.g.* unconsciousness or cardiac arrest. The second restriction is the occurrence of the incident. It has to be alerted from a public area for the application to notify. The app also provides first aid guides, a directory of defibrillator locations and sends your exact GPS location when an ambulance is notified using the app. In order to sign up as a first responder in the app, you need to have completed a CPR course [47].

SMS-lifesaver
SMS-lifesaver (SMS-livräddare) is a Swedish application which alerts volunteers, by SMS alarm, to a suspected cardiac arrest. The application can also direct the volunteer to a defibrillator. It is necessary to keep sound on on the phone in order to hear the alarm. The volunteers need to be over 18 years old and to have completed a CPR course. Studies has shown that when using SMS-lifesaver the amount of performed CPR has increased with 30 % [48].

Feature	ESKORT	FirstAED	St John	SMSlifesaver
Alerts	x	x	x	x
Map to defibrillators			x	x
Ability to accept/decline	x	x	x	x
Help with navigation	x	x	x	x
First aid guides			x	
Sign in/sign out options	x			
View other responders		x		

Table 4.2: Comparison of different apps for initial responders.

4.2.2 First Aid Applications

Save the Heart
Save the Heart (Rädda Hjärtat) is an application developed by HLR-rådet (the CPR council) and Hjärt-lungfonden. The application provides guide lines with both video and text instructions on how to perform CPR on children between 0-1, children above 1 year old and adults. Additional features are instructions for when there is a blockage in the airways and a map to the closest defibrillator [49].

The Red Cross First Aid
The Red Cross First Aid (Röda Korset Första Hjälpen) application is designed to provide information on what to do in the most common emergency situations. The applications have one "learn more" section, where you get comprehensive information regarding the situation you want to learn about, *e.g.* bleeding. For more brief information there is a section called "emergencies" where only the important information is provided. There is an option to get more information if wanted. There is also some quizzes for those who wants to test their knowledge [50].

Urgent Action
Urgent Action (Akutinsats.se) is provides instructions on how to act while waiting for an ambulance. In the application, you choose a category you want to learn more about and get both video and text instructions. The video instructions are quite long and are mainly focused on preparing you for what to do before an accident has occurred, the text instructions are a bit more divided into different steps and could possibly be easier to use as a guide during an emergency situation [51].

Cederroth First Aid
Cederroth First Aid is an application which gives picture instructions on how to perform first aid for 3 different age groups, 0-1, 1-12 and 12+. The areas they cover are CPR, air way blockage, circulatory failure, burn injuries and heavy bleeding [52].

4.3 Mobile Medical Devices

Here a selection of existing medical devices connected to simple smartphones are described. There are various brands and versions, these represent a brief range of different types.

Kardiamobile
Kardiamobile is an electrocardiography (ECG)-monitor which can be attached to a mobile phone and has been approved be the U.S food and drug administration (FDA). One measurement takes about 30 seconds. The patient simply places his or her fingers on the sensors, which can then measure both ECG and the blood pressure [53].

Drones
It is technologically possible to use drones to deliver defibrillators to rural areas today. It could potentially be a great help when cardiac arrests occurs as it has proven to arrive faster than an ambulance in many cases. According to a study conducted in Sweden it was on average 19 minutes faster than an ambulance when applied to rural areas [54]. It does, however, need permission from the Civil Aviation Administration (luftfartsverket) and the Transport Administration (trafikverket) in order to be allowed to automatically maneuver a drone outside the pilots vision. It is therefore not clear if this technology will be available for medical emergency system [55].

Mobisante Ultrasound
Mobisante Ultrasound is a device which can be connected to a windows mobile smartphone, making it a portable ultrasound system. The phone processes and renders images, the images can then also be shared to a PC via USB or email. This system is also relatively cheap making it more available for developing countries and rural areas [56] [57].

Kenek Edge Pulse Oximeter
Kenek Edge pulse oximeter is an application and a sensor developed for iOS systems by Lionsgate Technologies. It shines a light through the patients fingertip and detects how much of the light that is absorbed. After a few seconds it is able to calculate both heart rate and blood oxygen saturation which can be displayed on a phone [58].

4.4 Other Countries

The concept of using resource groups is spread across the globe. There are many examples of how different countries with rural areas work and even large collaborations between countries. The section below gives some examples of projects outside of Sweden.

The United States of America
The United Rescue in New Jersey has developed an app which is tied to the city's 911 system and alerts volunteer initial responders. The aim is to have someone in place within 3 minutes from an alert. The volunteers have received training from the United Rescue and should be able to provide emergency treatment while waiting for an ambulance, which usually arrives withing 9-11 minutes [59] [60].

Norway
In Norway a study was conducted to train lay first responders in basic life support and defibrillation. There was a focus on making sure that the responders were able to defibrillate a primary ventricullar fibrillaiton (PVF) in patients with acute myocardial infarction (AMI). During the five years that the study was carried out, no cases of PVF occured after the arrival of the initial responders and there was a very low number of AMIs which proved very surprising. No lives were saved by this project. There was, however, quite a small scale project so no real conclusions could be drawn [61].

Scotland Scotland has a system called community first responders. Community first responders are local volunteers who receive training in basic life support. Community first responders are supposed to be alerted on cases where there are signs of chest pain, cardiac arrest, difficulty in breathing, choking, medical collapse or an unconscious patient. They are also supposed to be part of a team, where a coordinator will organise an on-call rotation between the volunteers. The aim is to have one volunteer on-call at all times. The on-call volunteer is called out via telephone by the ambulance control center [62].

International Commission for Alpine Rescue
International Commission for Alpine Rescue (ICAR) is a collaboration between a great deal of countries all over the world. Some of the included countries are Sweden, France, Switzerland, Spain, Japan, Australia and the USA. They combine rescue forces on the ground, in the air, avalanche, alpine, dog-handlers and collaborate to increase knowledge and to improve handling of emergency situations in alpine areas or similar.

Each year a convention is held to teach and spread knowledge between different organisations and countries. Several avant garde procedures are explained in the 2018 convention; how to land a helicopter safely on a glacier, belays that are easy to handle and customised stretchers for difficult terrain. They also talk about the major impact the climate changes on glaciers, hence making rescue missions sometimes harder to predict [63].

5
Results

The following chapter will display the produced results and follows mainly the same structure as the method chapter. It will firstly present the outcomes of the concept phase, secondly the processing phase is presented. Thereafter results from the detailing phase are brought up and finally the demonstrator is introduced.

5.1 The Concept Phase

5.1.1 Interviews

At the end of the data collection phase, a summary of all data collected was constructed. The interviews were condensed down to what each person saw as problems in their part of the prehospital care chain, and possible actions to be taken in order to handle these problems, see below. A short summary of the context is written above each summary. The last interview was conducted with the goal to correctly, and in a reasonable way, construct a medical decision support and is therefore structured in a different manner and not included. The questions of each interview can be found in Appendix A. In figure 5.7 a visual representation of when the concepts should be involved in the prehospital care, understood from the interviews.

SvLc (Sjukvårdens Larmcentral)

Interview with an educated doctor with several years of experience in the emergency care unit, *e.g.* in ambulance vehicle and helicopters. The interviewed is now the medically responsible at sjukvårdens larmcentral (SvLc) VGR. SvLc operates in Västra Götalandsregionen and they are in charge of all incoming medical emergency calls arriving to SOS Alarm. Figure 5.1 shows how a call is being processed when a priority 1 medical emergency is identified and a helicopter is needed, according to the interviewed. At SvLc the receivers are educated nurses or with more medical education.

Current problems

- Sometimes it can take some time to find the exact position of the caretaker
- Proper equipment is required if vital data is to be taken into account in the evaluation phase

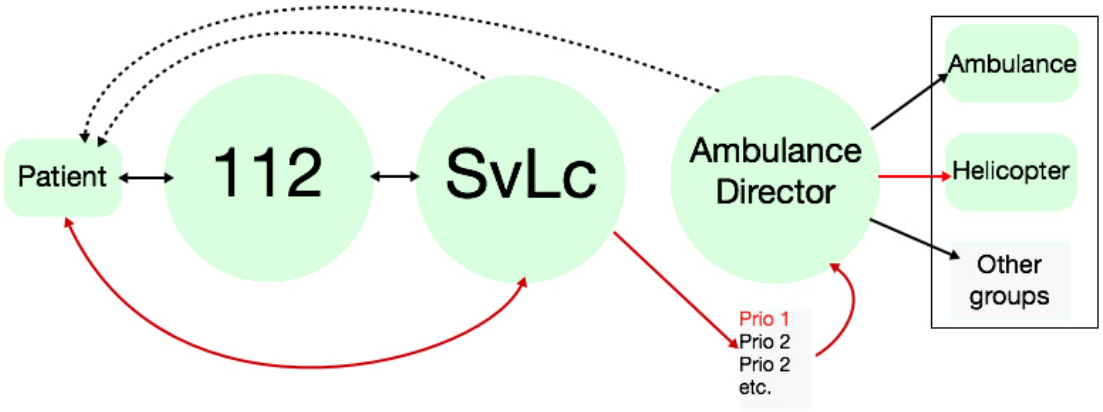


Figure 5.1: The dashed lines shows that one part is listening to the other. The red color indicates the final contact line. The groups in the rectangle to the right are possible resources to send out. The green are governed by the state, while the grey are different voluntary groups, such as SMS-livräddare. Here a patient calls 112, SOS Alarm, who opens a contact with SvLc, they listen together with the Ambulance Director until enough information is established. SvLc takes over the contact with the patient, decides prioritising, which is notified to the Ambulance Director, who will contact necessary resources.

Actions to take

- Get more accurate information about the caretaker, vital data can help with the decision making - however, the equipment must be approved [8]

OptiRes

The interviewed is an employee at Lindholmen Science Park, that carried out together with Norra Älvsborgs Länssjukhus and Uddevalla hospital (NU healthcare) the project Optimerad Resurshantering (OptiRes). OptiRes implemented a help system for SOS alarm, to shorten the time of arrival of first responders. They were provided with tablets, connected to nurses working with home care in municipalities in the NU-region. The tablets provided a map with available nurses, their current activity and status. They also had their estimated time of arrival (ETA) and contact information. In the other end, the nurses had an application in their phones where they could be called upon. They could choose to accept a received mission, see a map with the distance to the patient, ETA and, if they accept, further information concerning the patient.

Current problems

- Ambulances take a long time to get out into sparsely populated areas
- Attitude problems - operators do not use the newly provided service with pictures that come into SOS alarm

- The question of who bares the responsibility for taking a medical decision at SOS alarm
- Fear of making mistakes - send out the wrong prioritisation

Actions to take
- Engage district nurses via an app
- More frequently use OptiRes application [64]

Swedish Maritime Administration

The interviewed is an employee at the Swedish Maritime Rescue Society (SMA) and is currently a part of a major report concerning rescue missions in rural areas in parallel with providing emergency healthcare to the same place. The Swedish Maritime Administration is a state initiative. They are responsible for all rescue missions at sea and in the air in Sweden.

Current problems
- Organisational problem within the healthcare sector and the rescue responsible
- Coordination of resources - parallel contact between healthcare (limited rescue skills) and emergency services (limited medical knowledge), there is no communication between them
- Who carries responsibility for what - the Swedish Maritime Administration may have to take on healthcare tasks
- The healthcare chain is interrupted. SvLc makes a decisions - the contact with the caretaker is terminated (the phone call), an ambulance (or other resource) is sent out, or not. However, the situation can change over time, or initial information may be limited
- Structural problems - county councils, difficult to satisfy everyone's needs as they work according to different goals/in different ways
- Volunteer groups make decisions without any knowledge or reason of operating laws

Actions to take
- Create a medical decision support that is legally correct and backed by the county council
- Give a descriptive picture of the state of the caretaker as well as of the surrounding environment
- Usage of drones - to get a geographical overview of the site of the situation [9]

Swedish Sea Rescue Society

The Swedish Sea Rescue Society (SSRS) is a non-profit organisation consisting of a number of voluntary workers all around Sweden. SSRS perform around 83% of all

rescue missions at sea in Sweden and offers an alternative to the state rescue unit. It is an old foundation with self autonomy. The interviewed is a member of SSRS and operates from Chalmers University and is the head of a project called Maritime Human Factors.

Current problems

- County councils do not take responsibility for healthcare at sea - sea rescue may take on larger assignments than they have training for
- Non-professionals do not have any trauma-habit nor proper medical education - they do not have the courage to handle all the tasks they are sent on, uncertainty is created

Actions to take

- Do the right thing at the right time
- Create tools that are EASY to use to not "twist" the attention from the rest of the situation
- Aids with “tellers”, signals, that determine whether they should "stay and play" or "load and go" can be made with the help of vital parameters, however they must be easy to handle [65]

Swedish Maritime Administration - Rescue Swimmer

The interviewed works as a rescue man for SMA. There is quite a large spread on how good the medical education is for rescue men in SMA. Some have a medical background as nurses, ambulance or similar, while some have the education they have received during military training.

Current problems

- County councils do not take responsibility for healthcare at sea - sea rescue may take on larger assignments than they have training for
- Sometimes incorrect information from the scene of the accident is provided - the situation can prove to be worse or milder than described
- No standard medical decision support exists
- Common triage systems focus sometimes on the wrong things The caretaker might end up at the wrong hospital - too little information is carried out

Actions to take

- Regularly update yourself on medical information such as ABCDE or some kind of medical decision support
- Have a read aloud option - help to increase focus on performing tests and to go faster
- Divide prehospital care chain into different phases and provide information/alternatives based on these, remove away unnecessary information

- Setting goals for different situations - disease, trauma or similar
- Talk directly to those who make decisions, such as the doctors in the hospitals [66]

Rescue Resources

The interviewed has for many years been responsible for the rescue teams (since a few years back, counted as an IVPA-group) at Åstol but is no longer active partly due to injuries but also due to not getting enough help from the municipality. The rescue team at Åstol is not on call, whoever is at home when there is an alarm should respond to it, but there is no one who keeps track on who is available and who isn't.

Current problems

- Lack of contact to the right resources, such as rescue services when helicopters are to arrive
- Lack of contact between the people in the resource rescue group
- People do not dare to accept assignments if they are alone
- Logistical problems - the group must firstly reach the fire station to accept assignments
- An alarm is only sent out to the group in case of suspected cardiac arrest, however, stroke is the most common disease
- It takes a long time before an alarm to the group is sent out
- Too little and unnecessary information is sent out
- The group has three different tasks, information is sent out too late about certain tasks
- There are no standard reports to follow, reports could help similar settings learn from each other
- There is high competence present but there is no way for SOS alarm to make a use of it
- The ferry does not have a pager or similar
- If you do not complain about how serious it is, SOS may not send out the right resources
- Limited training update (for those not trained at a hospital)
- The group is not informed on which help that is sent out
- There is a too small contribution from the municipality in the sense of equipment and education

Actions to take

Create an app that can:

- Let you accept an alarm
- See who else is available
- Allow communication between the people in the group
- The group receives the same and simultaneous information as an ambulance

- Send out the exact position, for the patient and those who are on the move
- Communicate via facetime, or similar, to the resource coming
- Send out more informative information about the care taker and sent out resources
- List of competence levels of those in the group that SOS alarm can take part of
- Provide support for those who have less trauma-experience
- Offer constant contact to increase the sense of security when handling the patient
- Create a standardized report - a template for an alarm report and overall how to work when an alarm occurs [67]

5.1.2 Concept Ideas

The MoSCoW-model was used to sum up the conclusions above, along with the literature review. As the technique was utilised, three concepts were formed. See table 5.1, table 5.2 and table 5.3 for the resulting concepts. The project proceeded to see the result as several concepts, rather than one. In a design process a great interest lays in creating a broad perspective to narrow it down further on. Accordingly, continuing with several parallel ideas opens up to further development aspects. The different aspects brought up in the prehospital-care chain resulted in the following concepts;

1. *Medical Decision Support*: a system to help the decision making in a medical and/or trauma situation. The aim with this concept is to create a support mechanism for initial responders, mainly for IVPA-groups. The function would be to facilitate and help people with some, yet limited, medical education to prioritize the most urgent medical or traumatic injury, illness or similar and to help transferring this information with the goal to retrieve the accurate help at place. Similar to reporting a windshield report.

2. *Communication Support*: in rural areas, such as Åstol, there are a great deal of competent and obliging people for emergency situations. However, they lack means of communication to streamline this knowledge. Partly among themselves but also from the SOS alarm center. This concept would help people in voluntary resource groups, mainly for IVPA-groups, to distribute and utilize available competence and abilities. The idea includes creating a perception of "stronger together" in the sense of not feeling alone when answering an alarm.

3. *Quality Improvement*: given that parts of the prehospital-care chain is founded on limited medical knowledge and no definitive way of approaching a situation, there is no clear and standardised system for logging each event. Hence, contemplation and increased knowledge from each situation can easily pass by. Similar organisations, mainly for IVPA-groups, would be able to learn from each others mistakes and successes and improve collectively if a standardized protocol, or similar, could be filed at each happening.

Medical Decision Support	
MUST HAVE	**SHOULD HAVE**
Easy to use Intuitive Function on all android smartphones Provide an e-health solution to improve a current situation	Ability to help sending out right resource Decrease time line in care chain Connected to the cloud Triage system (or other priority system) Direct connection to alarm central Different information for different phases Follow Swedish laws/regulations Describe Priority Enter vital signs Information register (similar to 1177)
COULD HAVE	**WON'T HAVE**
GPS Environment description Audio Instructions ECG Oximetry Send information to SvLc Offline functions Send images/video Call via facetime Provide an objective for certain situations - transport or stay and care Alternative for signing in (where are you in the prehospital chain)	Be personal to each patient Ultrasound Contact drones

Table 5.1: The MoSCoW-model for the concept Decision Support.

Communication Support	
MUST HAVE	**SHOULD HAVE**
Easy to use Intuitive Function on all android smart phones Provide an e-health solution to improve a current situation	Decrease time line in care chain Connected to the cloud Personal account - be able to sign in Direct connection to alarm central Accept an alarm Contact with surrounding initial responders Different information for different phases Provide information concerning the patient Follow Swedish laws/regulations Environment description GPS
COULD HAVE	**WON'T HAVE**
Send information to SvLc Offline functions Alternative for signing in (where are you in the prehospital chain)	Be personal to each patient Ultrasound Contact drones

Table 5.2: The MoSCoW-model for the concept Communication Support.

Quality Improvement	
MUST HAVE	**SHOULD HAVE**
Easy to use Intuitive Function on all android smart phones Provide an e-health solution to improve a current situation	Be able to save data from different alarms Follow Swedish laws/regulations
COULD HAVE	**WON'T HAVE**
Template for alarm report/automatically create alarm report	Be personal to each patient

Table 5.3: The MoSCoW-model for the concept Quality Improvement.

After the three concepts were identified and specified, a Pugh-matrix was forged. Table 5.4 shows the result from this method. A concepts relevance is valued after certain criteria, and can either get a - (does not live up to criteria), 0 (neutral), or + (fulfills this criteria). The concept with the lowest score, the quality improvement concept, does not go in line with the beginning set goals, hence will not be focused on in further steps.

	Medical Decision	**Communication**	**Quality**
Innovative	1	-1	0
E health	1	1	0
Technical	1	1	1
Streamline resources	1	0	0
Save time in prehospital care	1	1	0
Needs: PICTA	1	0	0
Needs: Users	1	1	1
Focus rural areas	0	1	1
Compatible medical device	1	0	-1
Follows Swedish laws/regulations	1	0	1
Enhance communication	0	1	1
Gives prioritisation	1	0	-1
Can contact SOS	1	1	0
Encourage helping	1	1	0
Total	***12***	***7***	***3***

Table 5.4: A Pugh-matrix over three concepts at the top, and set criteria on the left.

5.2 Processing Phase

When entering the processing phase, the project was limited to two of the three concepts; the medical decision support and the communication support. Several personas were developed to put these concepts in a context, see table 5.5 for a brief view of the personas. Given that one of the primary personas have different needs than the others, the project proceeded to develop two separate scenarios, to not contradict and put the needs against each other. The project's limitations were also at mind when establishing the personas and the scenarios. The first scenario describes an emergency situation at Åstol, the resource group, counted as an IVPA-group, whom this project has put as its main user. The second scenario describes an event where the medical decision support is at focus, given that this matches the initial aims of the project. In Appendix B and C, the fully developed version of the personas and the detailed version of the scenarios can be found.

Name	Marie - PRIMARY	Kalle - PRIMARY	Greta - SECOND.	Torbjörn - PRIMARY
Age	61	48	87	27
Experience	Educated nurse	Former leader of resource group	-	SMS-lifesaver
Back-ground	Lives in a rural area, member of an IVPA-group	Lives in a rural area, member of an IVPA-group	Lives in a rural area	Sees great joy in being able to help
Motivation	She wants to grow older and feel safe at home	Many years of experiencing limited emergency care, the power of voluntary groups	Heart issues, does not like to visit hospitals	His parent was saved by an SMS-lifesaver
Need	Use resources at hand, create better communication	Streamline and organise current situation	To feel safe at home	Support in emergency situation

Table 5.5: A summary of the developed personas.

5.2.1 Low Fidelity Prototype

The scenarios helped in understanding the potential use of the two concepts further, hence, low fidelity prototypes, lo-fi prototypes of the concepts were done. Both of the lo-fi prototypes were created by hand on simple sketch programs.

In figure 5.2, 5.3, 5.4 and 5.5, four separate images are demonstrated to graphically show the thought on how a medical decision support can be modelled as an application. The idea is built much upon how ambulance personnel acts when arriving to an emergency. However, slightly simplified to not complicate it for the users and to focus on happenings that can impact prioritisation. Three S:es were mentioned in the interview with senior assistant master at the University of Borås, Department of Caring Science. The three S:es stands for; Scene, Safety, Situation, describes how to approach an emergency [68]. Here, they have been shortened down to two S:es, safety (säkerhet) and situation. The first S is equal to the S familiar from triage with S-c-ABCDE.

The prototype has a very early step to detect suspected cardiac arrest, which to some extinct can be compared to c (Catastrophic Haemorrhage Control) in S-c-ABCDE. The steps continue, were the user will have to chose between "toddler", "child" or "adult", this will result in different levels at some of the steps further on in the application. In this prototype "adult" is chosen. The option "indoor" or "outdoor" is included as this factor may affect prioritisation. Continuing, either "trauma" or "disease" will be elected, see figure 5.3, to distinguish what type of situation it is.

Further on, triage with ABCDE will commence, and the user will have different

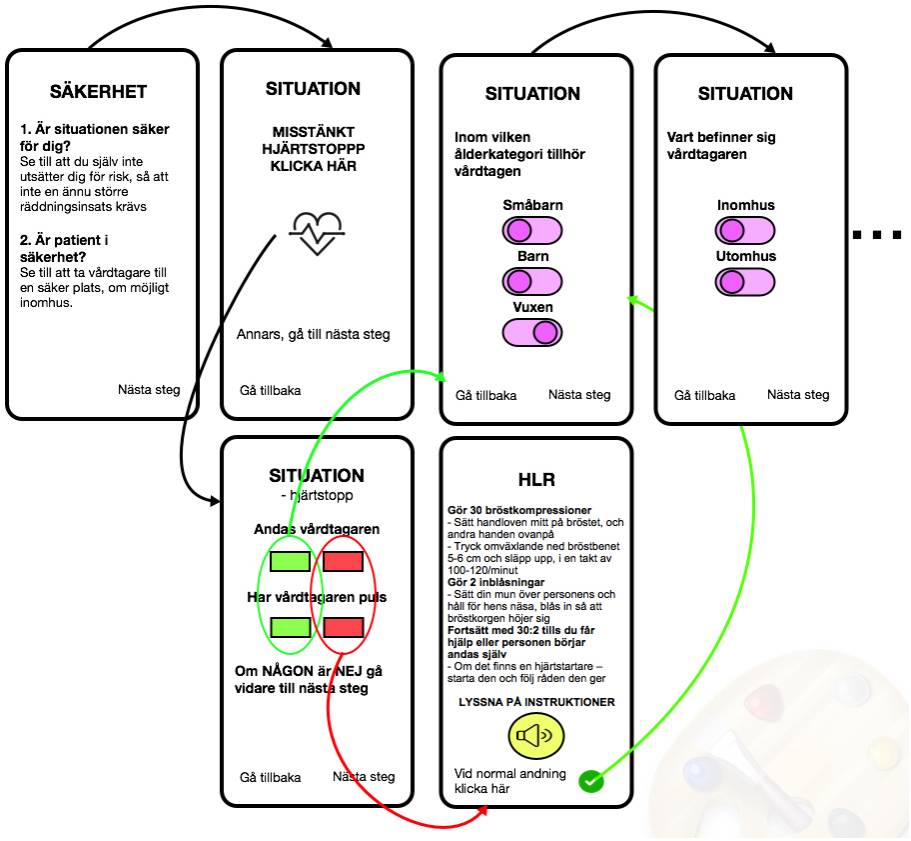


Figure 5.2: The first version of the low fidelity prototype, medical decision support concept, part 1.

options depending on the situation, see figure 5.4 and figure 5.5. The user can also chose to skip steps if he or she does not have sufficient information or time. The penultimate step in 5.5 will give the user a chance to put in his or her own perception of the situation. The final step is a summary of the information collected as well as a recommended action to take and a favored prioritisation.

There is one option to enter respiratory rate and one to enter the pulse, here instructions and a timer is put to facilitate the input. In case of need to put the patient in the recovery position, perform a jaw-thrust maneuver or to stop a bleeding, instructions are available with the help of images. Instructions to commence CPR may be given by help from the app in the sense of reading aloud.

The communication support prototype is shown in figure 5.6. The figure demonstrates how a user can sign into the application and decide to be "available" or "busy". If the user is available, it is possible to see who else in the near by area that are available. If there is an alarm, the user will obtain some brief information about the caretaker and the option to accept or decline the alarm. If the alarm is accepted a number of alternatives will be available; contact group, distribute roles among the members, see a map with the GPS-position of the caretaker and the phone numbers to several important stakeholders.

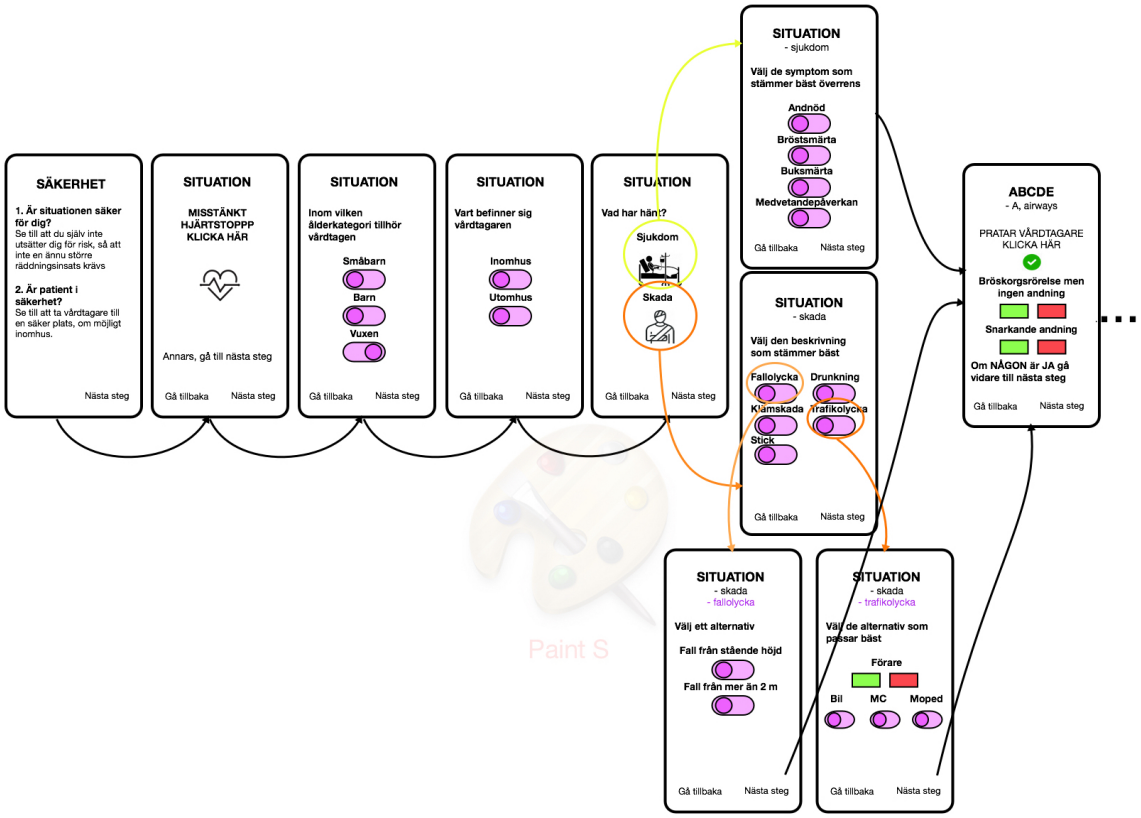


Figure 5.3: The first version of the low fidelity prototype, medical decision support concept, part 2.

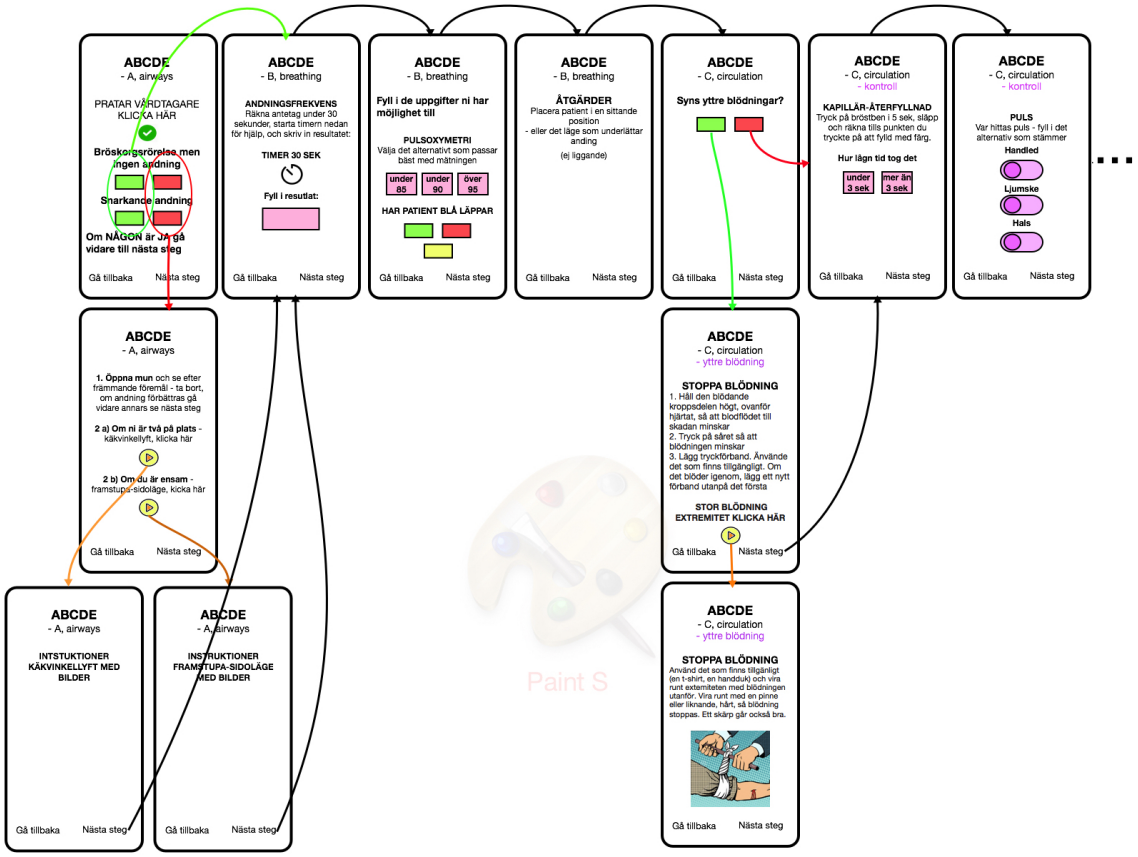


Figure 5.4: The first version of the low fidelity prototype, medical decision support concept, part 3.

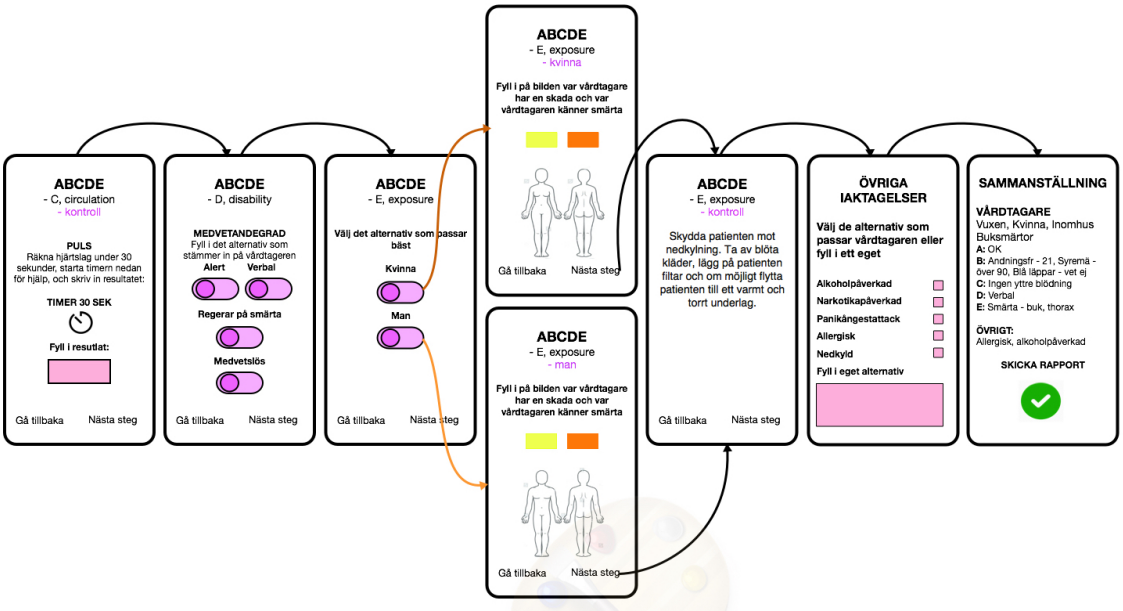


Figure 5.5: The first version of the low fidelity prototype, medical decision support concept, part 4.

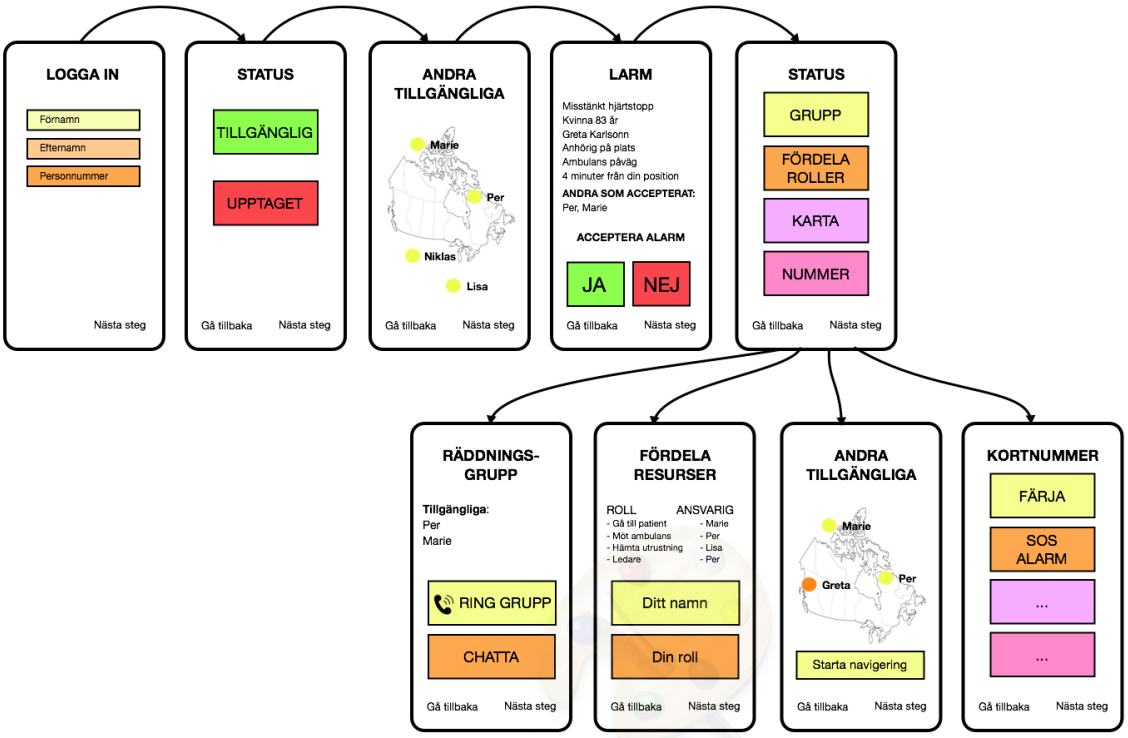


Figure 5.6: The first low fidelity prototype made of the communication support.

5.2.2 Evaluation of Low Fidelity Prototype

First iteration

The evaluation of the first prototypes was done by different parties;

- Responsible at PICTA
- Assistant professor in the section of caring science and working withing military prehospital care, *e.g.* NATO
- Associate professor in the section of caring science

The evaluation of the communication support concept resulted in that responsible parties agreed on not focusing on this further on in the project. Although the concept could prove useful to specific parts of IVPA-groups, the concept lacks in innovation and does not fit the aim to the same extinct as the medical decision support concept.

The first iteration in the processing phase concluded in some changes in the medical decision support concept. Inputs were simplified to easier step through the concept and additional features were added to better include common states of illnesses. Inputs on what the prioritisation algorithm should include, see appendix D, was also evaluated. Overall the structure remained, however a discussion concerning how the concept would fit the aim started. The need to include SOS alarm and SvLc VGR (sjukvårdens larmcentral Västra Götaland regionen) in the process further could be seen and was admitted to the next iteration.

Consequently, after the first iteration one remaining concept - the medical decision support prevailed.

Before the evaluation the process of the prehospital care and were the concept could improve the current situation was evaluated to bring to SvLc. See figure 5.7. IVPA-groups are alerted at the same time, or after an ambulance has received an alarm. This means that it is at the earliest from stage three in 5.7 the system can have any effect. By gathering extra information to bring to SvLc could help in their deciding for the need of a helicopter or not. Sending information to the ambulance while it is on its it way could help to prepare the ambulance personnel and thus reduce the time between stage six and seven in figure 5.7.

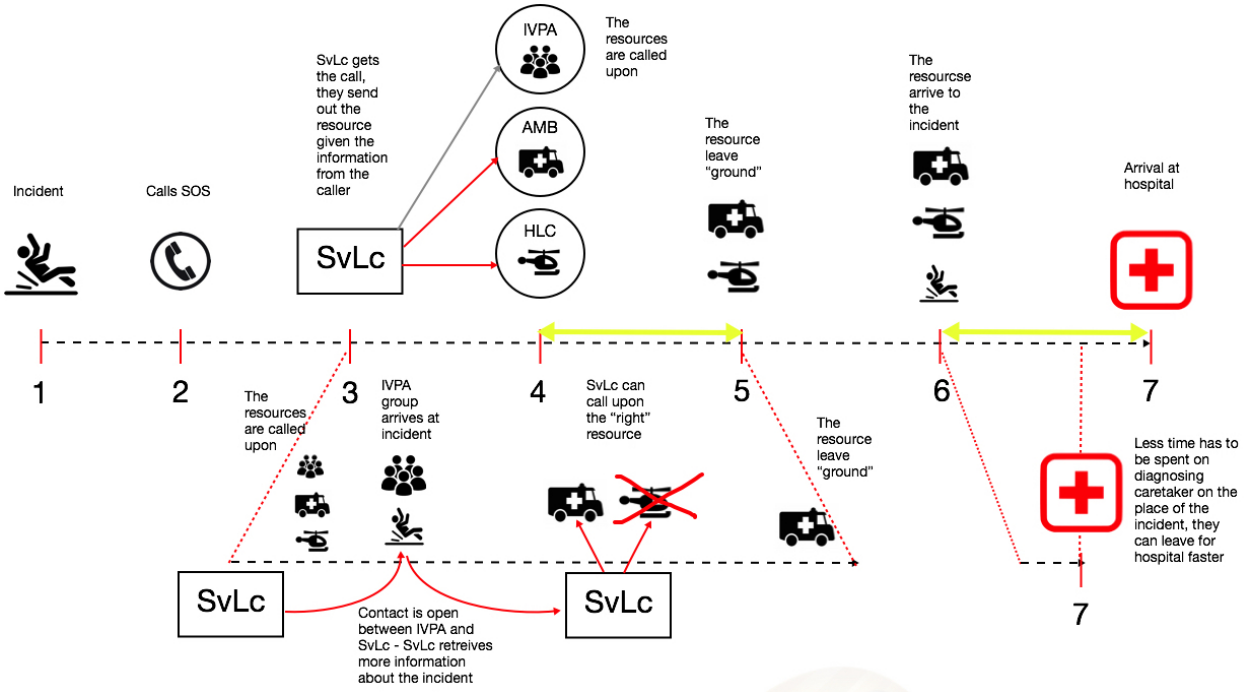


Figure 5.7: The prehospital care chain, where the two yellow arrows indicate where the concept could be used. The steps between 3 and 5 have been enlarged below the main timeline, with an optimal timeline, for how a new concept could affect the chain of events. The same under step 6 and 7, where the goal would be to shorten the time.

Second iteration

In the second iteration, the concept was valued by;

- Operations developer, employee at SvLc, VGR.
- Quality controller, employee at SvLc, VGR.

Several changes and aims were considered. The possibility to cancel sent out resources would not prove possible at this stage, SvLc needs to be able to determine

the state of a caretaker themselves. Therefore, the need of a prioritisation algorithm can be excluded. However, if data is collected in a systematic manner and presented in a certain way, familiar to systems used in the Swedish healthcare, the concept would be of interest. It is also valuable to enhance the patient value at an early stage and help in understanding the need for more resources, or to know really how time critical, or not, a situation might be [69] [70]. In this iteration too some steps were facilitated, skipped and some details were added, see appendix D for the final version of the lo-fi prototype.

5.3 Detailing Phase

5.3.1 High Fidelity Prototype/Demonstrator

A simpler version of the final application was constructed in MIT App Inventor. The prototype could be interacted with at a low level, however did not hold all wanted features. See figure 5.8 below for an example of two slides in the hi-fi prototype. In section 5.4 all slides of the prototype is shown. Unlike the lo-fi prototype, this version provided the possibility to step through the whole concept from start to end, using the buttons "go back" and "next". It was possible to get a grasp of the complexity of the concept, how time consuming, give or take, it proved to be. The hi-fi version also provided a more realistic sense of the interpretation of each feature.

(a) The first slide when controlling the breathing of the caretaker. The elected option is yellow.

(b) The second slide when controlling the breathing. A text is produced when pushing the buttons.

Figure 5.8: Two slides from the high-fidelity prototype.

5.3.2 Evaluation of High Fidelity Prototype/Demonstrator

A small focus group consisting of three people, all part of the IVPA-group at Åstol were invited to test the high fidelity prototype. The group members were:

- Previously responsible for the Rescue Recourse group at Åstol, person A below
- Retired Emergency Services employee and previously responsible for the local Rescue Services (räddningsvärnet), person B below
- Retired Anesthetist, person C below

The evaluation was performed jointly in the group, as well as individually. The prototype was stepped though from the first to the last slide. Several slides were considered to simple, or unclear, similarly to the first evaluation iterations. Design options were discussed and noted for further development. Overall, the concept remained in the same structure.

To measure the usability of the concept, how well it fits the usability goals, the System Usability Scale was used. The three results are seen in table 5.6. The average score landed on 72.5.

A	**B**	**C**
67.5	67.5	82.5

Table 5.6: Each persons total score using the SUS.

5.3.3 Design Options

Although a demonstrator is not a final application, some aspects of design was considered. With the aim of constructing an easy understandable application, used in time sensitive and stressful situations, it is important to have a simple, inviting design with great affordance.

The ability to understand what has to be done immediately is important. In the design options, the concept has been chosen to only include the most important, making the visibility easy to follow and lead the attention to mostly one thing per slide. Consistent design choices were made to facilitate the use of the concept. Each slide is similar to the next, the same disposition is used and build-up of each screen is consistent throughout the application. By giving feedback on each choice, and mark elected buttons and check boxes, it will facilitate the understanding on what has been done. In the design different colors were utilised to increase the affordance. Green for yes, and red for no.

5.4 Demonstrator

The final demonstrator is the high fidelity prototype developed with features and includes some of the fundamentals of the design principles. All slides offers differ-

ent choices to make. Each choice is saved throughout the use of the demonstrator and will be summarized in the end. Below, the slides are explained more thoroughly.

The demonstrator in a larger system is graphically shown in figure 5.9. It is thought to be accessible for IVPA-groups, and similar, with the option to sign in. It should be connected to a cloud-based system, making it possible to save all collected data, for control and for future use. The goal would be to via the 4G network be in contact with SvLc when a call has been placed so that they can see all inputs simultaneously. SvLc could then send information back to the group with information about sent resources.

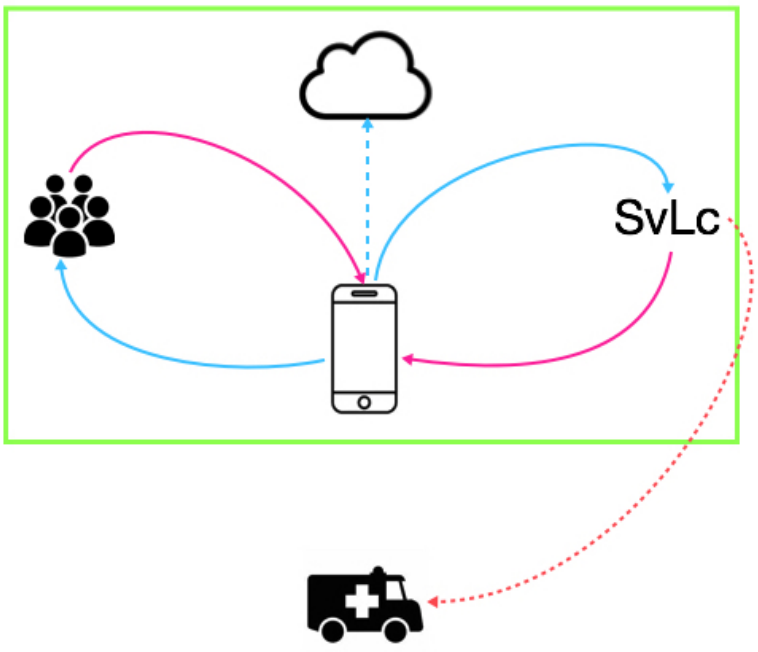


Figure 5.9: System sketch showing how the concept is thought to work. Everything inside the green square is thought to be included. The pink lines are for information sent to the concept. The blue lines show what information is sent by the concept. The dashed blue line is for information sent to a cloud-based system. The red dashed line is information sent by SvLc, outside the concept.

Safety
Firstly, figure 5.10a will address the safety of the patient and the care giver. Being in control of the safety can prevent more damage to happen. The elected button will be marked and a message under confirms with a sentence what the user has chosen. This is consistent in the whole concept.

CPR
Figure 5.10b will direct the user towards CPR if the patient is unconscious. The user will be shown to figure 5.10c, to control the breathing and pulse. If any of them are missing, the next step is 5.10d where instructions on how to perform CPR is given. The user is also offered the option to listen to the instructions, encouraged to

retrieve a defibrillator and given the possibility to start a timer when starting CPR.

Situation
The next slide, figure 5.11a, is reached if CPR not is needed. Here the approximate age of the patient is chosen. In figure 5.11b the user chooses if the patient is inside or outdoors. Figure 5.11c gives the option "disease" or "trauma" to elect depending on what best describes the situation.

Situation - Disease
Figure 5.12a a shows four options on common symptoms. One or more can be chosen.

Situation - Trauma
In figure 5.12 b, c and d different slides for trauma are shown. The description best fitted to the trauma can be elected in 5.12b, only one of the options can be chosen. If the trauma has been caused by a fall, figure 5.12c is shown, "fall from higher than 2 metres" or "fall from standing" are available. If the trauma is caused by a traffic accident, the user will be directed to 5.12d. Here it is possible to enter

- If the patient was in the vehicle or not
- What type of vehicle that caused the accident
- Approximately which speed the vehicle was driving in
- If there was a collision
- If any airbag was activated and if yes
- Which type of airbag that was activated

A - Airways
The ABCDE-algorithm starts in figure 5.13 with the airways. 5.13a is the initial control. If the patient is talkative, the user will be directed to figure 5.14a. Else, figure 5.13 b, c and d are available. The user will be asked to control the airways visually and remove any unwanted objects. It is possible to get instructions on how to perform a jaw-trust manoeuvre, shown in 5.13c and instructions for the recovery position in 5.13d.

B - Breathing
Now the user will control the breathing. Figure 5.14a gives three choices on how the breathing is interpreted; normal, fast or slow. 5.14b prompts the user to see if the patient is cold sweating and if the patient has blue lips (cyanosis). The slide also gives advice on how to position the patient if the breathing is limited.

C - Circulation
Figure 5.15 is for circulation. Firstly in 5.15a, external bleeding's are checked. If there are none, the user will be directed to 5.15d where the pulse of the patient can be entered. A timer is available to facilitate the counting. If external bleeding's are visible instructions for how to stop a bleeding in 5.15c is given, and instructions for how stop larger bleeding's are shown in figure 5.15d.

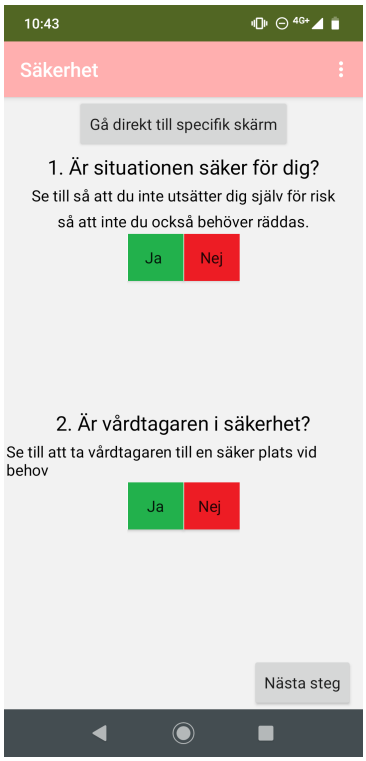
D - Disability
To address the disability figure 5.16a offers four options on how to describe the consciousness of the patient.

E - Exposure
Lastly in the ABCDE - algorithm the exposure of the patient is controlled. The sex of the patient is chosen in 5.16b. In figure 5.16c an image of the front and back of a body is shown. It is possible for the user to click where the patient is feeling pain and/or has an injury. In 5.16d the user can chose the approximate temperature of the patient.

Additional information
Figure 5.17 are all additional information, not usually included in the ABCDE - algorithm. Firstly in 5.17a, the user can add if oxygen has been given to the patient, and how much. 5.17 b and c gives the possibility to add information *e.g.* if the patient recently had an operation, or if the user has noticed the patient to be affected by alcohol. The last, 5.16d, will offer the chance to enter the medical education of the user or anyone else close by.

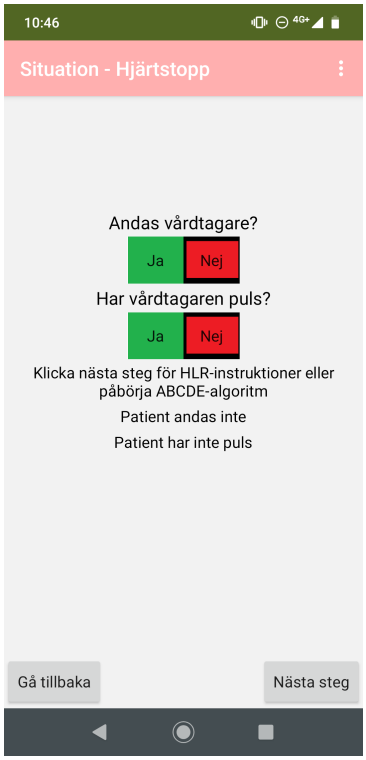
Compilation of information
The final slide figure 5.18 is a summary of all entered information. The information is sorted in a manner similar to a system, commonly used in the Swedish healthcare, called SBAR:

- S - Situation: what has happened and when
- B - Background: information such as medication or previous deceases
- A - Current state (aktuellt): the current state of the patient
- R - Advice (råd): advice on the next step in the process (not included in this concept) [70] [69]



(a) Check to control the safety of the patient and the caregiver.

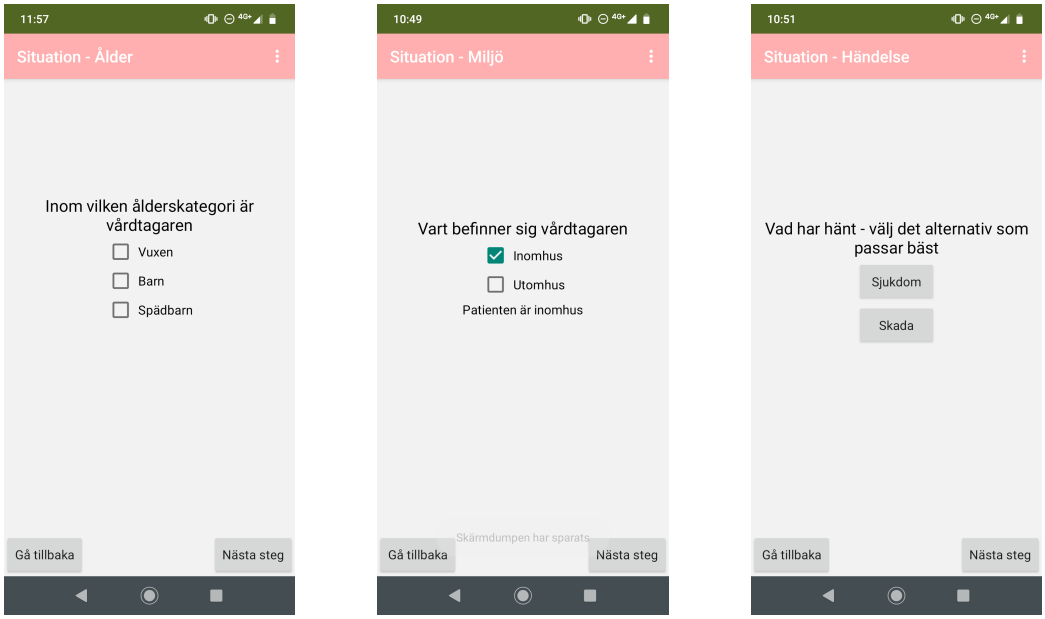
(b) If you suspect cardiac arrest press the heart.



(c) Check to control if the patient is breathing and/or has a pulse.

(d) Audible and written CPR instructions. A timer is available to time when the CPR starts and ends.

Figure 5.10: Demonstrator images; safety control, cardiac arrest control and CPR instructions.

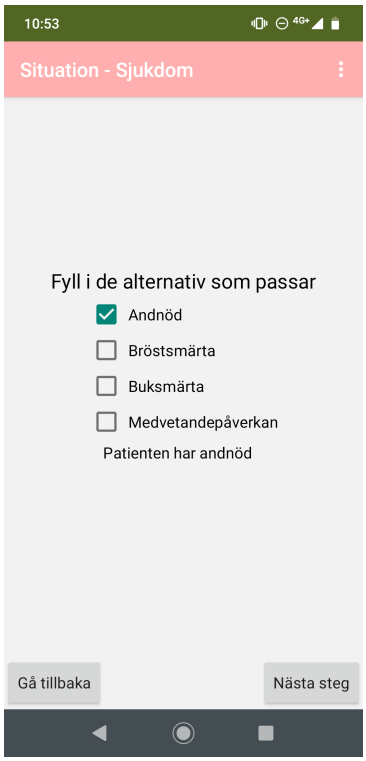


(a) Check if the patient is an adult, a child or a toddler.

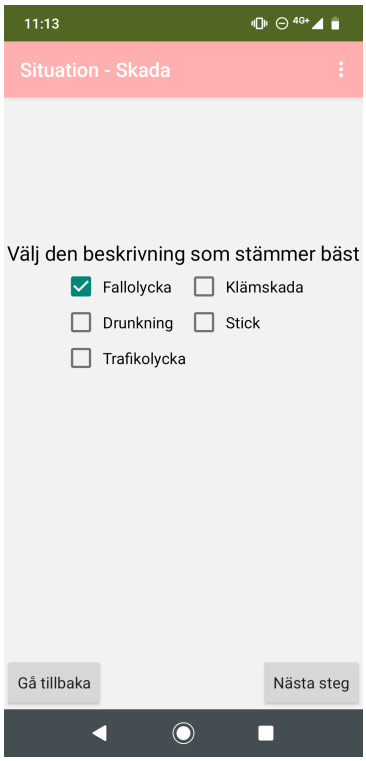
(b) Check if the patient is inside or outside.

(c) Check what the situation is, trauma or illness.

Figure 5.11: Demonstrator images; age, environment and situation.

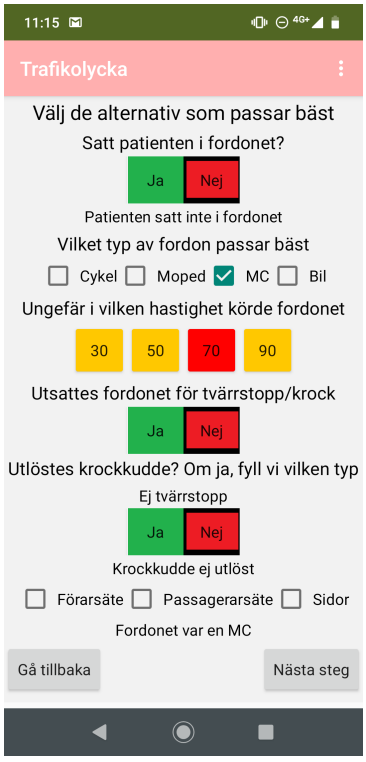


(a) Situation illness; possible symptoms - difficulties to breath, chest pain, abdominal pain or affected consciousness.



(b) Situation trauma; different categories of induced trauma.

(c) Situation trauma through a fall; option to chose fall from standing position or fall from higher than 2 meters.

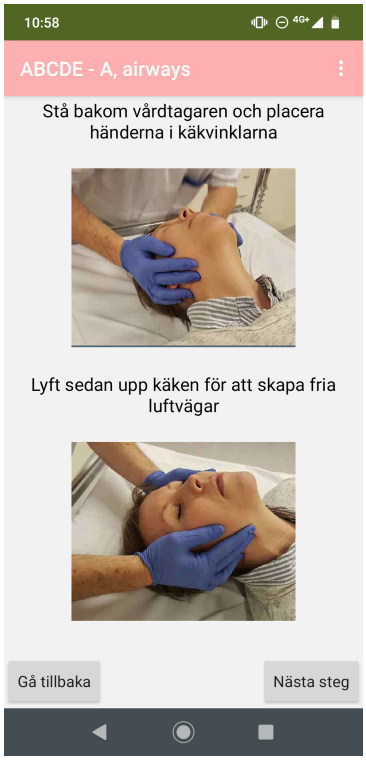


(d) Situation trauma traffic accident; option to fill in speed, type of vehicle, type of crash and if and airbag was induced or not

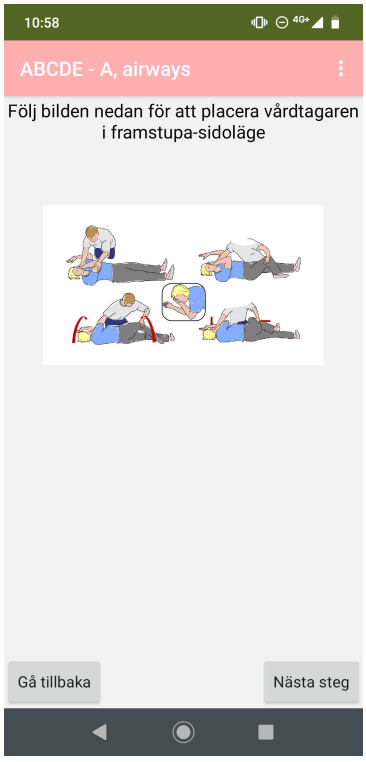
Figure 5.12: Demonstrator images; symptoms, type of trauma, type of fall and traffic accident options.

(a) Check to control the patients airways.

(b) Instructions for how to free the airways of the patient.

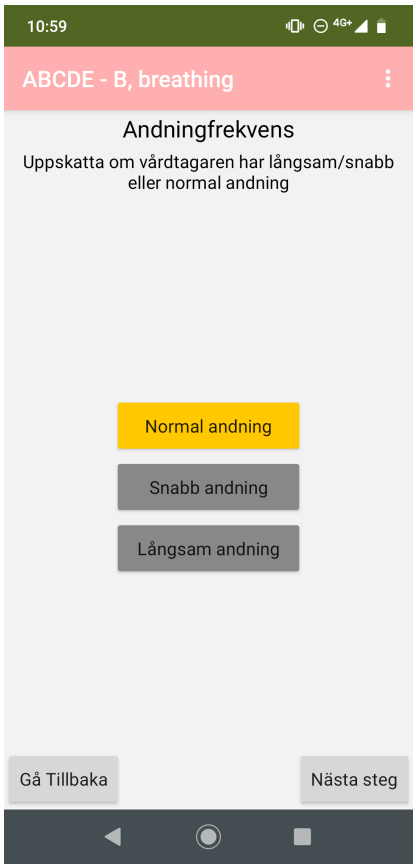


(c) Instructions for how to perform a jaw-thrust manoeuvre.

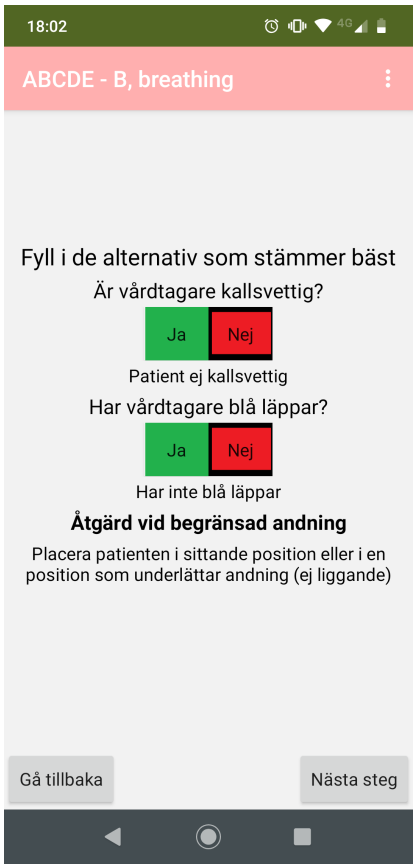


(d) Instructions for how to put the patient in the recovery position.

Figure 5.13: Demonstrator images; airway control, instructions to free airways, jaw-thrust manoeuvre and the recovery position.

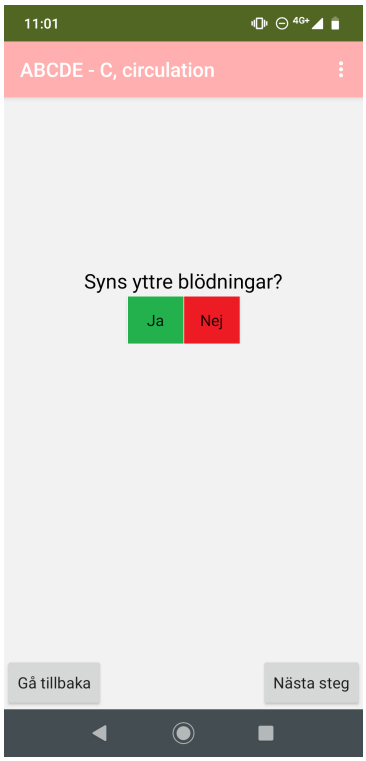


(a) Check to control the breathing frequency of the patient, normal, fast or slow.



(b) Check to control if the patient is cold sweating and/or has blue lips.

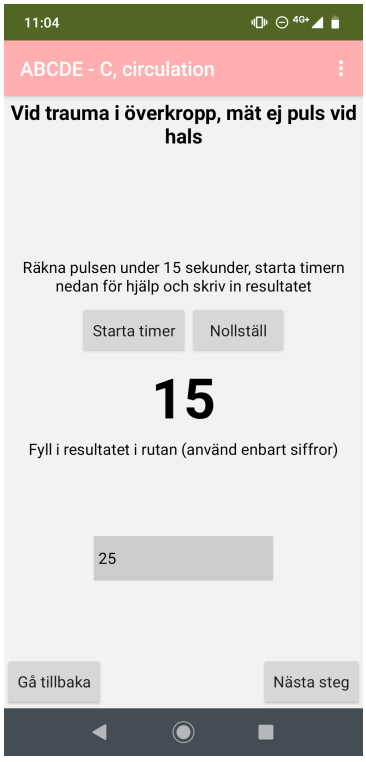
Figure 5.14: Demonstrator images; breathing frequency and possible cyanosis and cold sweat.



(a) Check to control any external bleeding.

(b) Instructions for how to stop a bleeding

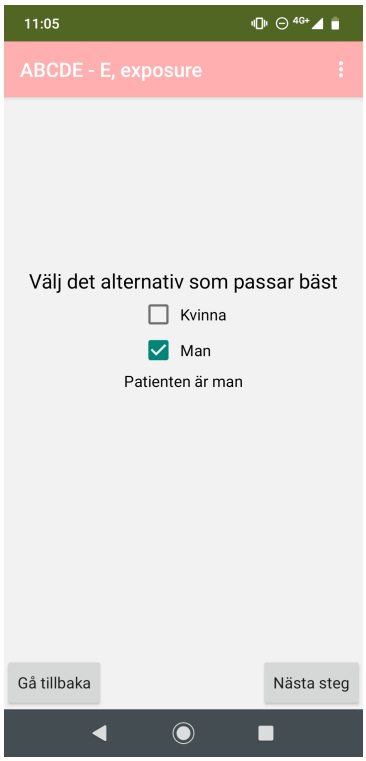
(c) Instructions for how to stop a larger bleeding.



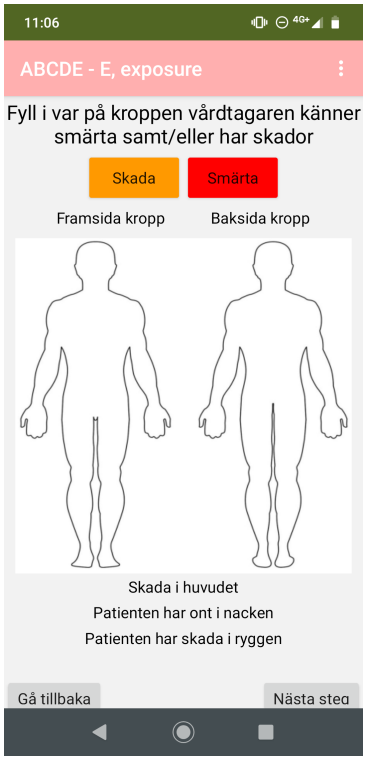
(d) Check to control the pulse of the patient during 15 seconds.

Figure 5.15: Demonstrator images; external bleeding, stop bleeding, stop larger bleeding and pulse control.

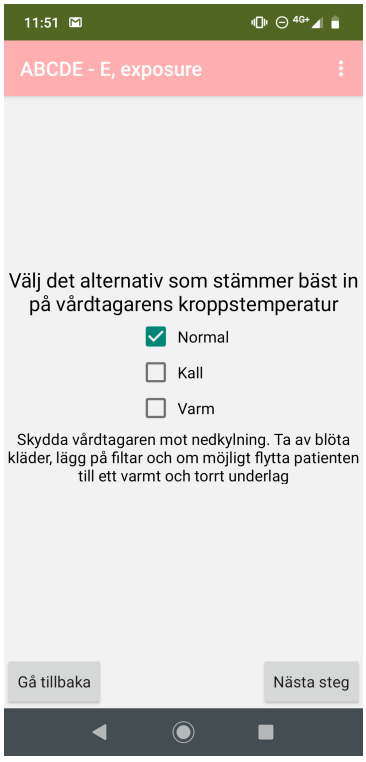
(a) Check to control the patients level of consciousness; alert, verbal, reacts to pain or unconscious.



(b) Check the sex of the patient.

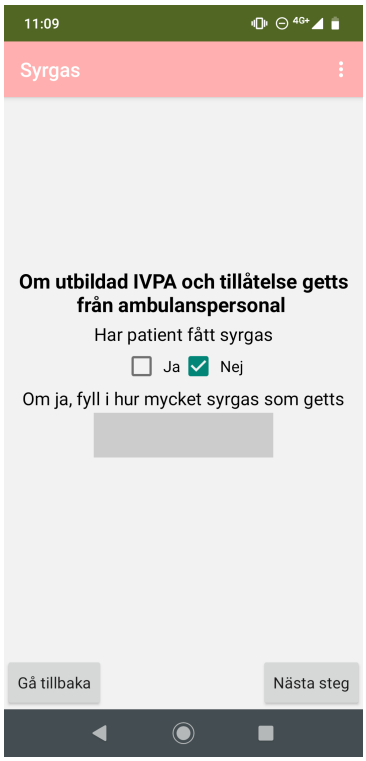


(c) Fill in where the patient is injured and/or feels pain.

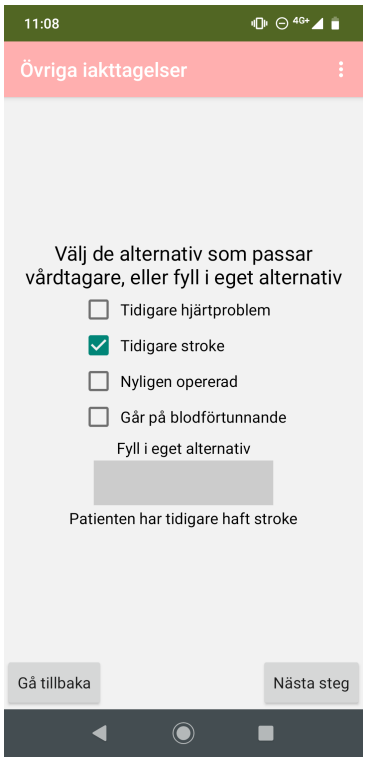


(d) Check to control the temperature of the patient; normal, cold or warm.

Figure 5.16: Demonstrator images; level of consciousness, the sex, pain/injury and temperature.

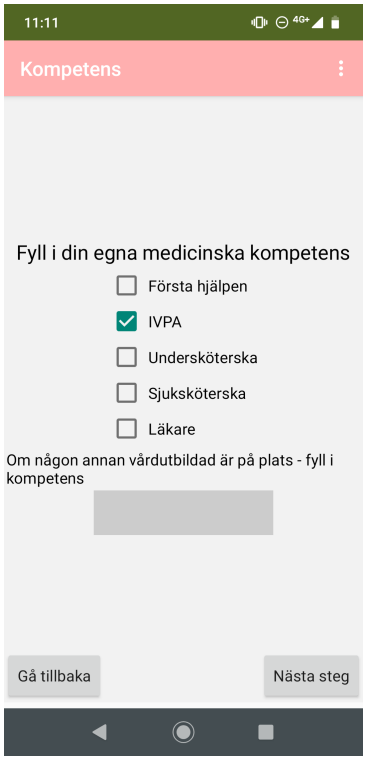


(a) Fill in if the patient has received oxygen gas, and if so, how much.



(b) Fill in additional information such as if the patient has previously suffered from a stroke.

(c) Fill in additional information such as if the patient is allergic or affected by alcohol.



(d) Fill in the care givers medical education and if someone else with a medical education is at place.

Figure 5.17: Demonstrator images; given oxygen gas, additional information 1, additional information 2 and medical education.

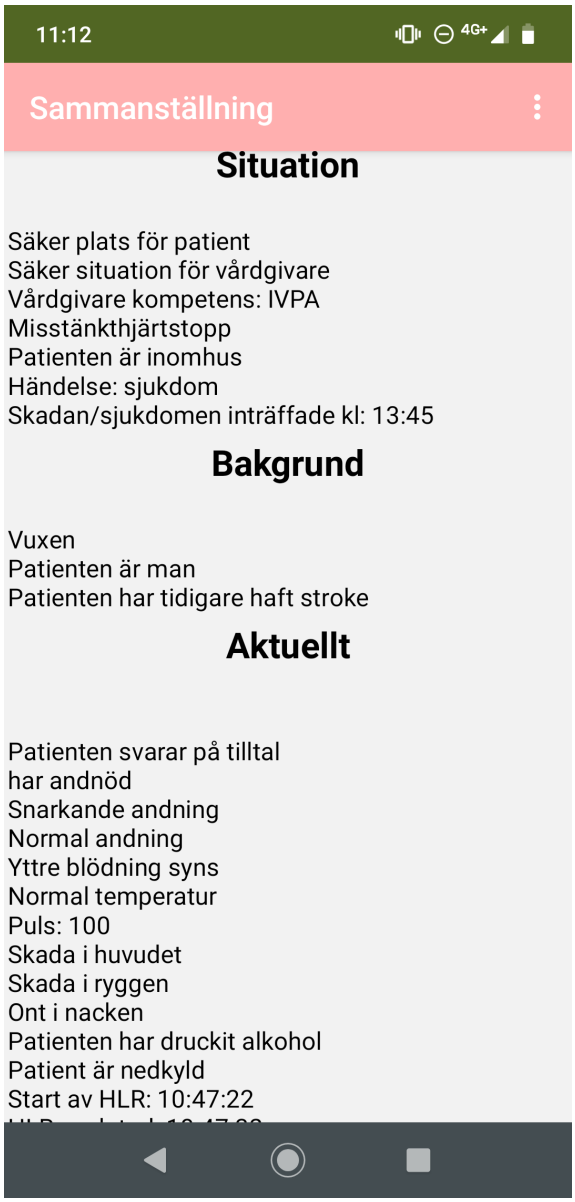


Figure 5.18: Demonstrator image; The gathered information collected in the application, ready to be transmitted.

6
Discussion

A discussion interpreting the results is written in this part of the project. The chapter is intended to sum up all aspects noted during the working process.

6.1 The Users

6.1.1 Potential Problems

Although volunteers have proven to be useful, and in many ways support today's healthcare, some issues arises when using people with limited education and experience. Medical incidents are many times quite traumatic, not only for the patient, but also for the care givers. Rural areas are often inhabited with a small amount of people, making the chance of encountering familiar faces when being an initial responder larger. Personal burdens such as embarrassment, lack of integrity, grief and responsibility could be possible problems. Confidentiality issues have also proven to be a potential problem to take into consideration [71].

Yet another upcoming issue is that volunteer groups not always get contacted. The problem derives from the lack of information. They might not be known to exist at the alarm centres. The volunteer groups don not have any requirement to be on site within a certain time, in these cases some counties only alarm semiprofessionals such as part time firemen instead, even though volunteers could be closer to the area and potentially help faster. There are also some confusions regarding the roles of the volunteers. In some instances communities have misunderstood volunteer groups as a replacement for ambulances [72] [71].

An additional complication is unwanted alerts. In Stockholm, alerts were sent out to volunteers in SMS-livräddare after an explosion even though the police had deemed the area as unsafe. The mistake was made as the caller failed to mention the explosion to SOS alarm. SMS-livräddare are now considering to add the possibility of sending a second SMS in cases where the situation turns out be unsafe [73].

The use of a mobile application in a stressful situation might be more of a burden than a facilitator. In situations placed outdoors with harsh weather it might prove tricky to concentrate on a phone. However, analogue support systems can be difficult in such situations as well, with the additional disadvantage of not being able to directly send a report based on the gathered data.

6.1.2 Military

In the military it is important to early be able to triage patients. There is a need to maximize the use of resources, as it can be many injured at the same time. The medical staff in the military have a short education focused on trauma and with information and accessibility to quite heavy medication.

The developed medical support system may be useful in the military as well, but would need some adjustments. It would need to have a higher focus on trauma and possibly also send the report structured in another way. Not SBA (SBAR originally) used currently but in a system called MIST (mechanism, injury, symptom and treatment) used in the military.

6.1.3 Police

Some of information gathered in medical support system might also be interesting for the police, specially the information gathered regarding traffic accidents.

6.2 Laws and Regulations

Volunteer groups are today not being alerted to many medical emergencies, even though they potentially could help. The reason derives from economical difficulties, it is simply too expensive to do so. According to law (2003:778) those who participate in a rescue mission should be compensated [11]. Therefore, rescue groups, or IVPA-groups, *e.g.* at Åstol, are only alerted in the most urgent cases, such as suspected cardiac arrest. Solutions to this could possibly be to have a small "permanent compensation" to those who are part of a rescue group, accordingly the group can help in less urgent cases as well and provide a better care for the patient. To have a permanent compensation may however prove be too cost full. Yet another alternative could be to let the volunteers choose if they are willing to help for free in less urgent cases. Hence, it would not be any difference from the current situation. The solution would provide an earlier, and possibly, better care for the patient. Another solution for small communities such as Åstol, could be to have an additional number to call for local resource group in addition to SOS. This solution would however require that the initial responders are willing to respond for free.

Law (2003:778) also mentions that a person is obligated to participate in emergency situations to the extent he or she is able to [11]. Individuals who have limited medical training may have the ability to help out more than they dare to, due to limited experience. The medical support system in this project could help with providing a little bit of extra confidence and additionally add knowledge and a systematic way to act, when not knowing, or remembering, how to.

According to regulation (2003:789) the Swedish Maritime Rescue Administration

are responsible for rescue missions at sea, although they are not medically responsible [12]. Despite the fact that they lack the responsibility in their job description, they still often have to deal with medical situations. The medical support system in this project could potentially be of help and support to compensate for limited medical experiences. The information gathered can also be sent to the medical staff, hence helping them to prepare for when the patient has been transported.

The health and medical care law (2017:30) explains the aim to provide a good healthcare on equal conditions for the whole population [13]. One of the criteria for this is to meet the patients need of security and continuity. In rural areas, where it may take long time before an ambulance arrives, patients will with most certainty feel more secure if volunteer groups are available and arrives early to provide care. The medical support system may be able to help the caregiver to feel more secure and therefore also able to make the patient feel safer. Moreover, another criteria is to have healthcare easily accessible, a criteria which could be met by volunteer groups.

The data collected in the application could possibly be kept and used to produce statistics, a step to implement future digitalisation possibilities and help to improve the healthcare. A feature which is allowed according to the patient data law (2008:355) [14].

6.3 Previous Solutions and Innovation

6.3.1 Medical Decision Support

Other First Aid applications, such as the Red Cross First Aid application, seems to have more focus on preparing the user before an emergency occurs. This differ from the solution for a medical decision support provided in this project, as the concept is based on the assumption that the user does have some previous medical knowledge. The user might however be inexperienced and could therefore still benefit from having instructions, or a guide to follow, but should not need to be quite as comprehensive as if it was someone without any previous knowledge.

Another difference between the concepts, is that the other applications assume the user to know what kind of emergency situation there is, *e.g.* a bleeding allergic reaction. The user has to select a category in order to get the instructions on what to do, without any priority suggestions if there are different conditions. For example, the patient could both be bleeding and have trouble to breathe. The application in this project follows the ABCDE-algorithm, where the patient is examined in a specific order to help the user prioritise what is the most important to do first. The concept additionally gathers information while performing the systematic examination.

The other applications does not save any data regarding the case, while the medical decision support designed in this project does. The collected data can possibly be sent to an ambulance, or SvLc, to provide additional information to the medical

staff at an early stage. This could speed up the process when the ambulance has arrived to the incident, or possibly help with deciding if an helicopter is needed or not. A comparison between the first aid applications previously mentioned in the report, and the medical decision system designed in this project, is shown in table 6.1.

Applications	First Aid Instructions	Saves Data	Prioritise
Medical Decision System	x	x	x
Red Cross First Aid	x		
Urgent Action	x		
Cederroth First Aid	x		
Save the Heart	x		

Table 6.1: Comparison between different first aid applications

6.3.2 Communication Support

The communication support system developed in this project is quite similar to the FirstAED application. They are similar in the sense that is possible to see the location of the other volunteers who are available, you get their contact information and its possible to assign different roles. One difference would be the ability to add different numbers to call quickly, for example on Åstol. It could be beneficial to add a number to the ferry as they might have to be ready for an ambulance. It would also be different with the group at Åstol, as they would divide the roles themselves instead of a the dispatch center doing so. It would also be possible to see who has accepted an alarm, before you do so yourself, compared to the FirstAED application where you only see the other responders after you have accepted an alarm. For users who are hesitant to accept an alarm, it might encourage them to so if they can see that someone else has accepted it first.

6.4 The Demonstrator

6.4.1 Removed Features

During the course of the project the demonstrator has had different features, most of which are still included, while some have been removed.

Initially, an option to fill in values gathered from a pulse oximeter was available. The saturation of the blood is a good indicator in some medical conditions. However, after the evaluation with Sjukvårdens Larmcentral (SvLc), the decision to replace it with a question concerning cold sweat was made. Their opinion was that the pulse oxymeter would not add any extra valuable information relative to the difficulties of collecting the values. For similar reasons the screen for checking capillary back fill was cut out. Capillary back fill can be very difficult to measure, especially for someone with limited experience.

At first the breathing frequency screen included a timer, and the possibility to manually add the counted breaths. After one iteration it was understood that it would be enough to enter an estimate of the breathing; slow, normal or fast. Contrarily, the screen deciding the patients pulse was only left with a timer, and option to indicate were it was found; the throat, wrist or groan, was removed.

When checking the exposure of the patient, it was from start a differentiation made between the male and the female body. This feature was removed as it proved unnecessary. When making such a surveying estimation it proved faster and easier to stick to one screen for both sexes.

Originally the idea was for the demonstrator to provide a prioritisation value at the end, this algorithm was also removed when discussed with SvLc. SvLc need to make their own prioritisation and are at this time not able to trust an outside application. A suggestion for how the prioritisation system could work can be found in Appendix D.2

6.4.2 Usability

One important feature for the medical decision support was to live up to the usability to goals, here meaning the ease of use mainly. This was evaluated by SUS test. The result from the test had an average of 72.5 where results above 68 means that the system has an above average usability. This result indicate that the medical decision support system is easy to use, however, it is based on a small sample size and would need to be tested further.

6.4.3 Improvements

The current solution would offer the gathered data collectively sent to SvLc as a report. An alternative way to send out the information, which might prove to be more efficient, would be to in real time have the form available to both parties. When the user fills in the data, *e.g.* the patient being verbal, no external bleeding and similar, SvLc would be informed immediately. They could fill in the report while being on the phone with SvLc. SvLc could also transmit possible actions to take, they would be able to inform the out-sent resource, or the application could directly be seen by the resource as well. Yet another improvement would be for the resource to be able to contact the user via the application, *e.g.* with information about the estimated time of arrival and to retrieve the exact location of the patient from the user to the ambulance or ambulance helicopter. It might also be advantageous if SvLc and the initial responders were able to talk with each other, that way SvLc could store the information the initial responder gathers even if he is alone on the scene and has his hands busy. SvLc would also be able to ask specific questions and guide the initial responder if needed in a faster way.

In figure 6.1 these possible improvements are illustrated. The rectangles represent different concepts. The green being the medical decision support, the orange is of

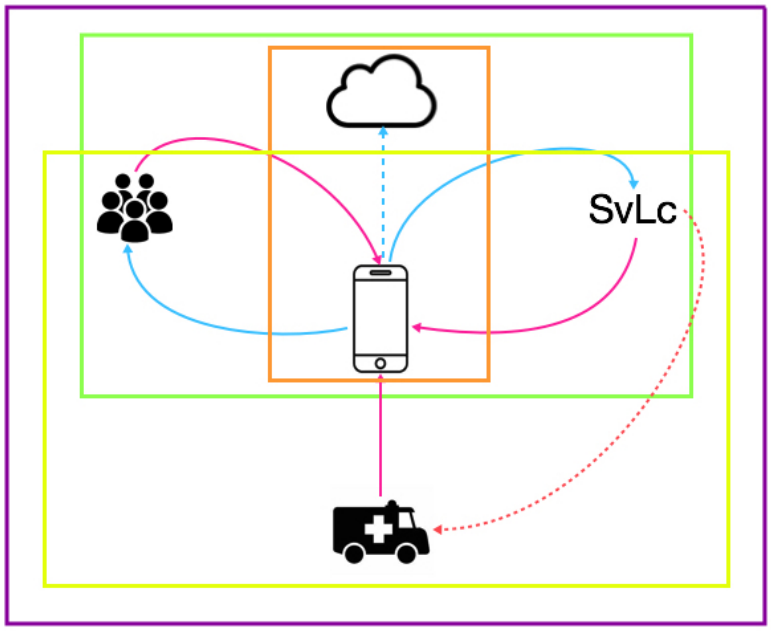


Figure 6.1: A system sketch with a suggestion on how to improve the existing concept. The orange square indicates all the retrieved information from the app, stored in the cloud. The green square shows that initial responders and SvLc are able to see if the other party puts something into the app. The yellow square represent the possibility for ambulance to directly see what the initial responders enters into the app and for the ambulance to transmit their arrival time. The pink arrows are for input information and the blue for transmitted. The red dashed line is an already existed communication.

the quality improvement, and the yellow would be of improved communication. The purple rectangle is a concept consisting of all these concepts developed in the initial part of the project, and the aim for possible changes.

6.5 Future Work

The first steps in possible future work on this project would be to test the demonstrator. The concept needs to be analysed to find out if it actually would be beneficial and also to learn more about possible changes. It would be evaluated in a larger group, with simulations of realistic situations. Furthermore the concept should be tested from both parties, both initial responders and personnel at SvLc.

In its current state it is also incomplete. Instructions and parameters are currently based on adults only but should be different depending on which age category the patient belongs to. It is also only possible to fill in injuries/pain on the head, neck, back and chest when the idea is to be able to fill in injuries/pain on the whole body. The complexity of the algorithm could also vary based on the users medical knowledge. It would also be favorable to add further features, *e.g.* the possibility to read and learn more about certain conditions, to make it more complete.

Future work could additionally include the use of artificial intelligence to possibly help with diagnosis, retrieve statistics or maybe to work on an ideal algorithm.

6.6 Ethical Considerations

The integrity of the patient is an ethical issue to consider. How much of personal information is perceived okay to transmit? Situations in the emergency care are sensitive, which makes the patient vulnerable. The concept is currently taking in information without the personal data of the patient. Therefore, the data is more structured as separate values and is not connected to an individual. According to the patient data law (2008:355) it is also granted to pass on personal information, if the means are to improve the healthcare [14]. Accordingly, future development of the concept would be under this law, making the ethical aspects considered.

7
Conclusion

The conclusions from this thesis are below structured after the initial aims of the project.

The first aim was to *"Perform a pre-study to map the current e-health solution for initial responders"*. There are existing e-health solutions available, yet limited to only a few medical conditions, available to few people and not developed for all groups involved. We can conclude in existing further needs; to include as many parts of the prehospital care chain as possible. The need to follow laws and regulations, offer systematic and consistent tools can be seen in many of the involved parties.

Secondly, we wanted to *"Perform an analysis of the needs regarding initial responders as well as for interested parties in the healthcare sector"*. We have seen the demand for increased sense of security and self reliance for the initial responders. They also, together with SvLc, wish for a better use of existing resources (both available as responders and out-sent resources) and overall, save time in time critical situations. The Swedish healthcare is very complex and there are many aspects to consider when creating new concepts. To find a common solution, meeting all needs would lead to many possible improvements. Initial responders will be further relied upon, specially in rural areas, hence the need for development is growing.

We then had the aim to *"Produce a concept/demonstrator for a complete e-health solution"*. The final demonstrator was formed using an iterative design process, with user experience and usability goals at focus. The process has helped in concluding the overall looks of the concept and the structure to produce a demonstrator. In conclusion, a user-focused iterative process is a helpful tool to use when developing a system with the central purpose of meeting certain needs.

Finally, we wished to *"Evaluate the demonstrator together with the intended users"*. We can conclude that the produced demonstrator is simple to use and potentially helpful. It would be able to help in providing extra information early on for medical staff on their way to an accident. It could also help SvLc to decide the size of the rescue mission needed, if more or less help should be sent. The demonstrator could be useful as a support for inexperienced responders, induce help to overcome limited trauma experience and increase performed live saving actions in critical situations.

The concept developed in this thesis is not completed. Future works are needed to

evaluate how the demonstrator can develop and help in real life situations. The need for more developed tools, better contact, use of resources is seen and could be met in the future if the concept would be further studied. There are many enthusiasts in the prehospital care chain that could benefit from future developments, and they would help to improve the whole healthcare chain over all.

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A

Interview Questions

Sjukvårdens Larmcentral

Purpose: To understand the process when an alarm occurs and investigate possible actions for improvement.

Understanding the process
Tell us about yourself and your profession
Explain the process of a received alarm and your relationship to SOS alarm
What type of information do you receive
Which level of education do the employed have
Describe a typical scenario

Decision making
Who decides the level of prioritisation
In what way do they make a decision

Improvement
Do you see any shortcomings in today's approach
What do you think works well today
Would vital parameters be useful information

Lindholmen Science Park

Purpose: To get an insight in how a current communication application is constructed for a certain group of initial responders (medically educated nurses). Additionally to understand why an initiative with a image decision support for SOS alarm not succeed.

Optires
Understanding the concept
Tell us about yourself and the project OptiRes
How does the application work and when is it used
What is expected to be done the initial responders
How has the application been received by the users
Describe a typical scenario

Decision making
How do the users make a medical decision, do they receive any help

Improvement
What is currently working good/not good
Would support in decision making be useful

Image support
Understanding the concept
How did the image support work
- what type of data was sent
- how was the data sent

Decision making
How was the data used to make a medical decision

Improvement
What was the reason to end the project

Swedish Maritime Rescue Society

Purpose: To get a deeper understanding of the problematics in rural areas and how rescue missions are executed in areas such as the sea and other extreme areas today.

Understanding the process
Tell us about yourself and your profession
Explain the process of a received alarm and your relationship to SOS alarm
What type of information do you receive
Which level of education do the employed have
Do the rescuers have any medical devices

Decision making
Who decides the level of prioritisation
In what way do they make a decision

Improvement
Do you see any shortcomings in today's approach
What do you think works well today
What would help your profession on a daily basis

Swedish Sea Rescue Society

Purpose: To learn how a rescue mission works in practice for voluntary resources

at sea.

Understanding the process
Tell us about yourself and your profession
Explain the process of a received alarm, who contacts you
Describe a typical scenario
What type of information do you receive
Which level of education do you have
What type of medical devices do you have

Decision making
In what way do you make a medical decision

Improvement
Do you see any shortcomings in today's approach
What do you think works well today
Would a help system prove helpful in your profession

Swedish Maritime Rescue Society

Purpose: To learn how a rescue mission works in practice.

Understanding the process
Tell us about yourself and your profession
Explain the process of a received alarm, who contacts you
Describe a typical scenario
What type of information do you receive
Which level of education do you have
What type of medical devices do you have

Decision making
In what way do you make a medical decision

Improvement
Do you see any shortcomings in today's approach
What do you think works well today
Would a help system prove helpful in your profession

Rescue Resources

Purpose: To get insight in how a resource groups work, how the level of communication is handled, what difficulties there are and what is needed to improve the current situation.

Understanding the concept
Tell us about your group and your background
What type of information do you receive
How do you send out information
Which level of education do you have
What type of medical devices do you have
Explain the process of a received alarm, who contacts you
What are the most usual happenings
Describe a typical scenario

Decision making
How is the process in case of a medical emergency
Do you have any certain routines, any help systems

Improvement
Do you see any shortcomings in today's approach
What do you think works well today
Would a help system prove helpful in your profession

University of Borås, Department of Caring Science

Purpose: Find out what the acute symptoms are that you can use to perform triage. What is important to include when making medical decisions.

Background
Tell us about your background and research area

Medical decision
How do you commence when arriving to an emergency event
What do you prioritise
When would you always give priority one
What can be done at an event by someone with limited medical education to facilitate before an ambulance arrives
Are there any vital parameters that would be possible to collect with limited medical education
Do you see any use of a medical decision support application
What is important to include in such application
What can be excluded

B

Personas

SCENARIO 1

IVPA-Medical Experience - PRIMARY

Name: Marie Utbildad
Age: 61
Experience: Educated nurse with many years of experience. Marie has several times before been called to emergency situations while a caretaker is waiting for assistance.
Background: Marie lives with her husband, together they have two children who live on the mainland. They moved to Åstol three years ago, to prepare for her and her husband's retirement. She is well acquainted with the local geographics and tends to keep calm in stressful situations. She is a part of the local IVPA-group.
Motivation: Marie has experienced the death of a neighbour at Åstol. An woman of 91 had a heart stop and even though many people know CPR and would have been able to interact, the alarm came to late and the woman died of heart failure before anyone from the recourse group was notified. She is worried that a similar situation can happen to herself or anyone else on the island as the population is getting older and help often is quite far away.
Problem description: Åstol is an island with limited access to the mainland. When emergency assistance is needed and the time is critical many dangerous and life threatening situations occur. Marie is not very familiar with the use of mobile applications.
Needs: Marie would like something that would help her know when and were an emergency occurs. She wants to be able to help when needed at Åstol, were all medical knowledge is of great use. It can take a long time before the right help is sent and she wants to be able to use all the resources possible, as well as increase and streamline the current communication on the island, with the SOS alarm included. She also wants to see people with less medical education dare to help in emergency situations, it is always better to do something than nothing at all.

IVPA-No Proper Medical Experience - PRIMARY

Name: Kalle Öbo
Age: 48

Experience: Former leader of a resource group, in charge of helping in case of fire on the island where he lives and closeby areas. Kalle has first aid education.
Background: Kalle has for many generations lived at Åstol and has been a great part of organizing the current resource group. He has a large family, four children and a wife. Three of the children now live on the mainland. Kalle wants to live on Åstol and feel safe and secure, for him and his surroundings sake, while doing it. He is well acquainted with the local geographics and tends to keep calm in stressful situations. He is a part of the local IVPA-group.
Motivation: Many situations in Kalles life have been characterized from the fact that he lives on an island. The birth of his children, diseases within the family, accidents when the summer guests appear are few examples of when his limited knowledge is put to test and he plus other brave people on the island have been forced to interact.
Problem description: Åstol is an island with limited access to the mainland. When emergency assistance is needed and the time is critical many dangerous and life threatening situations occur. Kalle has worked hard to improve communication within the island and to SOS alarm, but there seem to be limitations. The resource group he has created do not get education, nor alarms on time or all the alarms for that matter.
Needs: Kalle wants to streamline and organise the current situation. He wants to have certain decided assignments distributed and a clear chain of event standardized for when an emergency situation occurs. Kalle also wants to be able to improve after each mission, and to have a way of cheaply educate and motivate new people to join the group for when he is not available.

Caretaker - SECONDARY

Name: Greta Vårdtagare
Age: 87
Experience: -
Background: Senior living at Åstol with her husband. Does not like contacting doctors if there is no ABSOLUTE need for it. She receives homecare some days a week. Greta enjoys watching Grand Designs and swimming in the ocean most part of the year.
Motivation: As Greta hate hospital environments, she tends to stay at home rather than taking a long trip to the mainland. Receiving home assistance has proven a great compromise for her and her husband, as he is worried for her heart. She has been experiencing chest pain in the nearby past.
Problem description: The days when no assistance is provided for Greta, her husband is greatly worried. He knows that Åstol lies far away from the nearest hospital and they both know how long it can take for help to arrive.
Needs: Some kind of security placed on the island, so that they both would feel safe in their everyday life.

SCENARIO 2

Volontaire - PRIMARY

Name: Torbjörn Livsglad
Age: 27
Experience: Has participated in a First Aid course and is a member of SMS-lifesaver.
Background: IT consultant in the centre of Gothenburg and since a few weeks back member of a voluntary recourse group. He has been looking for new motivations were he can put some of his focus off his workload. Hence, Torbjörn has participated in local courses such as pottery, learning Italian and another one where he learned First Aid.
Motivation: Torbjön likes to help others and to engage in different contexts. His dad was saved by an SMS-lifesaver a few years back and has since then taken a greater interest in medical aid. He is quite familiar with the importance of CPR and how time is a critical factor for cardiac arrests, but also within other medical-related situations.
Problem description: He has limited medical knowledge and general little experience of trauma situations.
Needs: Help in knowing what to do when arriving to an emergency situation. He needs help with what to say to SOS alarm and with how to help the person in need until an ambulance arrives. Torbjörn would also like something to boost his courage and to dare to do something, rather than being a useless standby in an emergency situation.

C

Scenarios

Scenario 1 - Local IVPA-Group Rural Area
Combination medical decision support concept and communication support concept, two different applications.

People included in the scenario:

Marie Utbildad - primary persona
Kalle Öbo - primary persona
Lisa Öbo - daughter of Kalle (not a persona per say)
Greta Vårdtagare - secondary persona
Tomas Make - husband of Greta (not a persona per say)

Greta and Tomas are situated in their house at the island Åstol, part of a group of islands outside of Gothenburg. After a calm night of watching TV and enjoying the sunset together, Greta and Tomas go to bed around 11 PM. At 1:15 AM, Greta wakes up with intense chest pains. Tomas directly calls SOS alarm, Greta faints and Tomas feels scared and lonely.

SOS alarm send the call forward to SvLc, were they co-listen and put a prioritisation 1 on the call. SvLc directs the emergency to the Ambulance Director, who calls for an ambulance as all helicopters currently are unavailable. The director notices a resource group located at the place of the emergency and sends out a notice to this group. Tomas contacted SOS through a fixed line, hence their GPS-position is available and noted to both resources on their way.

Marie, Kalle and Lisa are awoken by a high pitched alarm from their mobile application. They are all signed in on the app, and have created a personal account where they are put as available resources. They all, separately from each phone opens the app and can see that:

- A female, age 87, has a suspected cardiac arrest.
- An ambulance is on its way.
- Who else that are available and who has accepted the alarm.

Kalle and Lisa accepts the alarm, which Marie notices and accepts as well. The following is now shown on the app:

- The exact GPS-position of Greta and her full name.
- A communication-thread between the acceptors, they can contact each other

in an sms-group or through a group-call.
- Who the leader is of the group and available tasks to hand out for the leader (the leader is decided among the group prior to the emergency, or distributed by the app).

Kalle is put as leader, the tasks distributed are; Marie and Kalle are sent to the caretaker, while Lisa's task is to collect their means of transport and retrieve their medical equipment. Kalle's task also includes contacting the ferry, connecting Åstol to the main land, to make sure they are ready for the ambulance.

- Kalle calls the boat via the app, while he is on his way to Greta.

Marie is the first to arrive to the emergency, were she finds Tomas next to a fainted Greta. She has her phone ready and opens the application for the medical decision support, and quickly finds the button for suspected cardiac arrest. She is instructed by the app to:

- Check for breathing and pulse. She commences CPR with the help of the spoken instructions from the app.

Kalle arrives and takes care of Tomas until it is his turn to perform CPR. Lisa arrives a few minutes later with the defibrillator. Marie uses the defibrillator, the pulse and breathing of Greta returns. Marie opens the app, clicks on the option for returned pulse and breathing and the app shows:

- Triage in the form of ABCDE, she follows the instructions and enters the vital parameters she can and answers other questions asked by the app.
- The app presents suggestions for how to best take care of Greta until further help arrives and returns a windshield-report, presenting retrieved values and estimated prioritisation of the caretaker.

The boat contacts the resource group via the communication app and notifies that the ambulance personnel are on their way, however the ambulance is stuck on the mainland as the weather conditions does not allow for ambulance transportation. Lisa follows through on her task and goes to collect the personnel, to show them the way to Greta.

The ambulance personnel arrives. They collect Greta and receives the gathered information collected by the medical decision support app. The gathered information from the app helps the personnel in prioritising their actions when taking care of Greta.

Kalle, Marie and Lisa finishes the mission in their communication application on each phone. The app returns to its neutral condition. Marie closes the app for medical decision support.

Scenario 2 - Individual Helper
The medical decision support concept.

People included in the scenario:

Torbjörn Livsglad - primary persona

Niklas Fall - caretaker (not a persona per say)

Torbjörn sits in the sun, a lovely June day. Nearby he sees a younger man, Niklas, slipping on the bathing cliffs. The man collapses and he bleeds from his head. A relative to Niklas calls SOS alarm, they immediately send for help. Torbjörn hurries to Niklas to help. Torbjörn is prepared with an application in his phone. He opens it and follows its instructions:

- He passes the first page - the situation is not dangerous for neither him nor the caretaker.
- He passes the option of suspected cardiac arrest, he chooses the alternative “adult” and that they are located “outdoors”.
- He arrives to the alternative “trauma” or “disease” and chooses the former.
- He clicks the option “fall accident” and selects “fall from standing”, the app now send him to Triage though ABCDE.
- A - the caretaker can speak, Torbjörn can continue to the next step.
- B - there is a lot of noise and disturbance, hence he can not decide the respiratory rate and continues to the next step. He also does not have access to pulseoximetry and thus does not enter anything in that box. He can answer whether the lips are blue or not ("yes", "no" or "don’t know"), which they are not.
- C - he clicks “yes” on the question if any outer bleedings are visible. He is shown by the app how he should do to control the bleeding.

Torbjörn puts Niklas bleeding in a high position, he has a heavy bleeding from the forehead, hence he needs to have the head above the heart. Torbjörn uses a towel as a pressure bandage as instructed by the app.

- C - he performs a control of capillary backfill, and enters in that he has found pulse in the wrist. Torbjörn does not enter the calculated heart rate, and continues
- D - Torbjörn notices that Niklas flicks with his eyes and seems a little confused. He does the AVPU test (fill in the option that best suits the situation); talkative, but not alert.
- E - Torbjörn, with the help of Niklas, fills in a picture of a body, where he feels pain and if it is just "pain" or "injury" or both. The app tells Torbjörn to keep the caretaker warm.

In the last frame of the app, Torbjörn has the option to add information he has observed with the caretaker, such as; alcohol-influenced, suspected panic attack, drug-affected, cooled, allergy or other.

The app presents suggestions for how to best take care of Niklas until further help arrives and returns a windshield-report, presenting retrieved values and estimated prioritisation of the caretaker. The app presents a priority level 2. Torbjörn sends the report automatically to SvLc (alternatively calling SOS alarm again, or keeping in contact with SvLc during the time he has been using the app) giving them the priority, the helicopter can be averted and an ambulance can now be sent. Torbjörn closes the app.

D
Low Fidelity Prototype

D.1 Final version

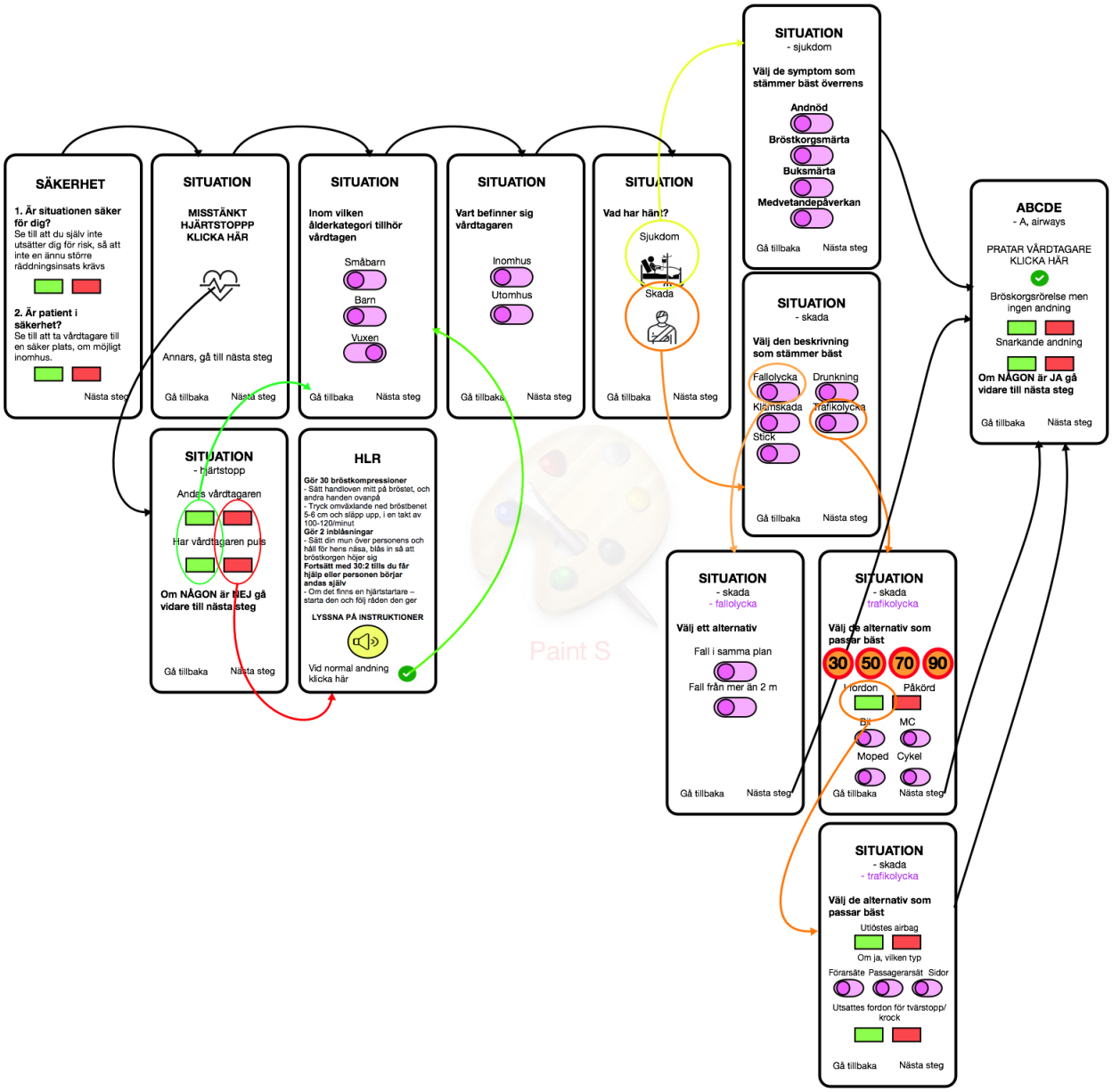

Figure D.1: The lo-fi prototype of the medical decision support, the first phase, final version.

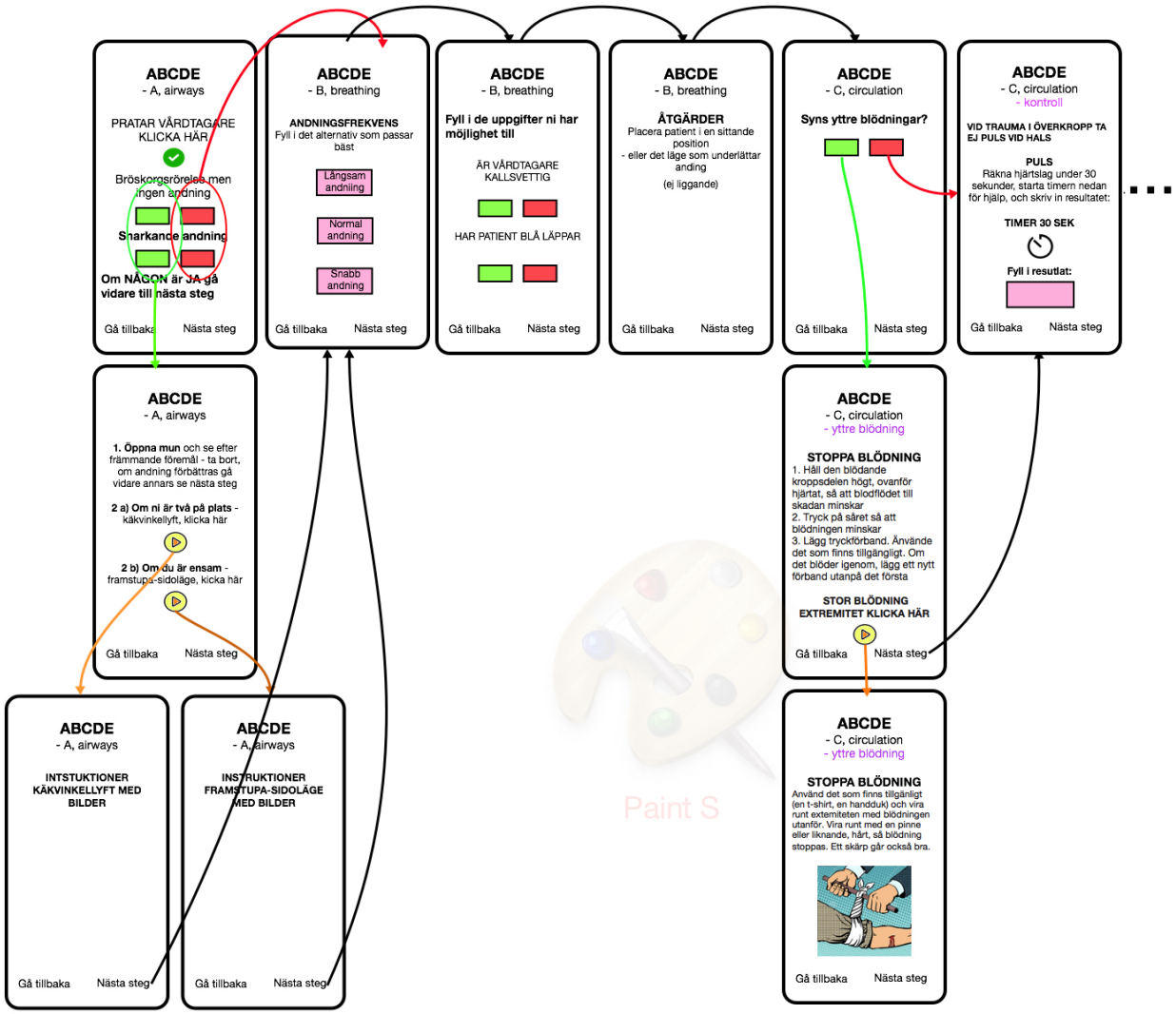

Figure D.2: The lo-fi prototype of the medical decision support concept, the second phase, final version.

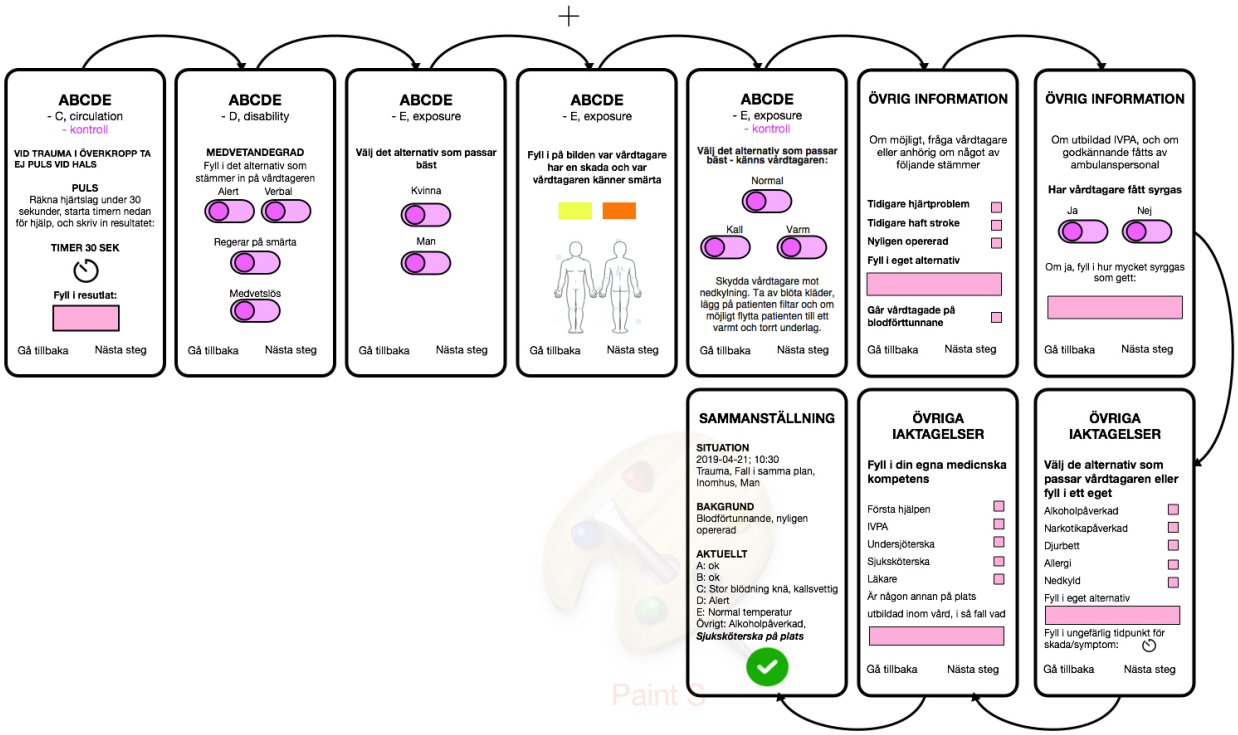

Figure D.3: The lo-fi prototype of the medical decision support concept, the last phase, final version.

D.2 Prioritisation Algorithm

One of the aims of the project was to offer a prioritisation number for a caretaker, in order to streamline available resources. Hence, an easier algorithm was decided upon for the detailed implementation of the concept, see table D.1.

The algorithm was based on knowledge coming from experienced trauma personnel and saves the decided numbers put on chosen variables. The highest number received, will be the number of the prioritisation, however inverted when presented in the report (prio 1 is the most urgent one for SOS alarm). Some variables were not possible to number, but had the aim however to be additional information in the final windshield report given when using the concept.

Safety/Situation				
Safety	**Cardiac Arrest**	**Age**	**Postion**	
Yes: 0 No: 3	Yes: 3 No: 1	Toddler: 3 Child: 2 Adult: 1	Indoors: 1 Outdoors: 2	
ABCDE				
Respiratory System	**RR (adult)**	**Oxygenating**	**Cyanosis**	**Outer Bleeding**
Free: 0 Snoring sound: 2 Chest movements no breathing: 3	5-10: 2 10-15: 0 15-20: 1 20-30: 2 >30: 3	<85: 3 <90: 1 >95: 0	Yes: 3 No: 0	Yes large: 3 Yes small: 1 No: 0
Capillary Backfill	**Pulse (adult)**	**AVPU**		
<3 seconds: 0 >3 seconds: 3	50-100: 0 100-120: 1 <50: 3 >120: 3	A: 0 V: 1 P: 2 U: 3		

Table D.1: The variables used to determine prioritisation when using the medical decision support concept. A prioritisation of 1-3 will be decided, 3 being the highest one (translated into prio 1 in the SOS alarm system).