

# Storage solution for a reusable auto injector

Malin Andersson & Saga Filipsson

DIVISION OF PRODUCT DEVELOPMENT | DEPARTMENT OF DESIGN SCIENCES  
FACULTY OF ENGINEERING LTH | LUND UNIVERSITY  
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MASTER THESIS



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Malin Andersson & Saga Filipsson



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Department of Design Sciences  
Faculty of Engineering LTH, Lund University  
P.O. Box 118, SE-221 00 Lund, Sweden

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Supervisor: Damien Motte  
Examiner: Olaf Diegel

# Abstract

This master thesis describes the product development process of a storage solution for a reusable auto injector concept consisting of a reusable unit and a disposable unit that contains the drug. The purpose was to understand the users and the environment that the injector is used in to investigate in the possibilities of creating added value in a storage solution concept. The project was carried out on the behalf of SHL Group, a world leading company within drug delivery devices.

To understand the users and their needs, the first part of the project was a literature study followed by interviews with users, pharmacists and health care professionals. The outcome revealed differences among the user needs and showed that the cooling requirements of the drugs were considered one of the greatest issues. Three personas were created based on the interviews to represent typical users in the target group. The personas were used during concept generation, evaluation and selection.

The final concept is an electronic cooler consisting of two parts that can be detached. The bottom part works as a refrigerator with space for four disposable units and is equipped with a thermometer that is connected to a temperature display. The top part, the case, has space for the reusable unit and one disposable unit. The solution is flexible and portable and both parts can be used separately and together.

**Keywords:** Product development, Reusable auto injector, Storage solution, SHL Group, Multiple Sclerosis, Rheumatoid Arthritis, Juvenile Idiopathic Arthritis

# Sammanfattning

Det här examensarbetet beskriver produktutvecklingsprocessen av en förvaringslösning till en återanvändbar autoinjektor bestående av en återanvändbar enhet och en engångsenhet innehållande läkemedel. Syftet var att förstå användarna och den miljö som injektorn används i för att undersöka möjligheterna i att skapa mervärde i ett förvaringskoncept. Projektet utfördes på uppdrag av SHL Group, ett världsledande företag inom läkemedelsleveranssystem.

För att förstå användarna och deras behov utfördes en litteraturstudie och intervjuer hölls med användare, apotekspersonal och vårdpersonal. Resultatet visade att användarnas behov såg väldigt olika ut och att ett av de största problemen gällde medicinernas kylkrav. Baserat på intervjuerna skapades tre personer med syfte att representera typiska användare i målgruppen. Personerna användes vid konceptgenerering, evaluering och val av koncept.

Det slutgiltiga konceptet är en elektronisk kylförvaring som består av två delar som går att ta isär. Den undre delen fungerar som ett kylskåp med plats för fyra engångsenheter och är utrustad med en termometer kopplad till en temperaturdisplay. Den övre delen, fodralet, har plats för den återanvändbara enheten och en engångsenhet. Förvaringen är flexibel och portabel, och båda delarna kan användas var för sig men också tillsammans.

**Nyckelord:** Produktutveckling, Återanvändbar autoinjektor, Förvaringslösning, SHL Group, Multipel Skleros, Reumatoid Artrit, Juvenil Idiopatisk Artrit

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# 1 Introduction

*This chapter introduces the master thesis and the company where the thesis was carried out. The problem is defined through an initial brief, goals and resources of the project as well as an initial delimitation.*

## 1.1 SHL Group AB

SHL Group (Scandinavian Health Limited), hereafter referred to as SHL, is one of the world's largest solution providers in design, development and manufacturing of advanced drug delivery systems. The company was established in 1989 and has grown globally with locations in Sweden, USA, Taiwan and China. SHL consists of several distinct group companies specializing in different areas within medical technology.

This master thesis will be conducted under the department of Research and Innovation at SHL Medical. SHL Medical designs, develops and manufactures advanced drug delivery devices such as self-administered auto injectors, pen injectors and inhalers for leading pharmaceutical and biotechnological companies. These devices allow patients to take their medications in their homes.

## 1.2 Problem description

### 1.2.1 Initial brief

The department of Research and Innovation at SHL Medical aims to develop concepts that will become the solutions of next generation's healthcare. SHL Medical has a concept of a reusable auto injector for self-treatment of patients with different autoimmune diseases and various state of health. The

concept consist of a reusable unit and a disposable unit. The disposable unit will contain the medicine which must be stored cold. The reusable unit does not have any cooling requirements and could therefore be stored in many ways. SHL is looking for a safe way to store the reusable unit, protecting it from its surroundings. They are also looking for extra features that can add value to the users.

Several user studies have been made within the field of auto injectors and injector pens, mainly focusing on patient adherence and satisfaction during the injection process. Storage of the devices is usually not covered which makes this an unexplored area in a human-centred perspective.

This thesis seeks to find a safe and innovative storage solution that will be an accompaniment and add extra value to the reusable auto injector concept. Focus will be on understanding the lifestyles and needs of the users and the regulations, needs and expectations of storing medications and medical devices. The research will serve as a scientific basis for this- and for future projects at SHL.

### **1.2.2 Goals**

This master thesis aims to develop a storage solution concept for the reusable unit of an auto injector used for self-treatment. To achieve this, the following partial goals will be essential:

- Gain knowledge about relevant therapy areas and injection drugs.
- Understand the environment that the auto injector is exposed to in order to develop a solution that protects it from its surroundings (dust, water, children etc.).
- Understand the user needs to identify requirements and expectations and seek for extra functionalities.
- Evaluate concepts with users.
- Establish recommendations for further development based on the research.

### 1.2.3 Resources

SHL provided during the thesis work necessary equipment for the project as well as workspace at their office in Nacka Strand, Stockholm. Employees at SHL Medical contributed with their knowledge and experience.

### 1.2.4 Initial delimitations

Since the reusable auto injector concept is not launched on the market, there are no detailed specifications available. When needed, currently existing injectors will be benchmarked to get an understanding of injection processes and devices.

The thesis will focus on chronic diseases where injection treatment is done at home. In agreement with SHL, the project will cover the therapy areas multiple sclerosis (MS), rheumatoid arthritis (RA) and juvenile idiopathic arthritis (JIA).

In this thesis, the user is defined as a person with a disease from the therapy areas that uses an injection device for self-treatment. These people are potential users of the reusable auto injector concept. Although healthcare professionals and parents injecting their children are potential users as well, they are excluded from the definition.

As the project is carried out in Sweden, the experience from users and healthcare professionals will be based on Swedish culture and healthcare conditions. However, the research will not be strictly geographically limited.

Costs and cost calculations will not be included in the scope of the project.

The project aims to develop a concept within the medical technology area. As the storage will serve as an accompaniment and its way of distribution is not defined, this project will not investigate in regulatory aspects.

### 1.2.5 Definition of an auto injector

An auto injector is a drug delivery system that contains a set dose of a particular drug and is designed so that a subcutaneous injection can be self-

administered. This enables users to treat themselves in their homes. There are both disposable and reusable auto injectors on the market.

An injection with an auto injector can be achieved with one hand and the dose is automatically injected when activating the device. The device is activated by pressing the device against the injection site on the body. The needle is hidden throughout the process. An example of a disposable auto injector from SHL is illustrated in Figure 1.1.



**Figure 1.1.** Example of a disposable auto injector from SHL.

## 2 Methodology

*This chapter covers the planning and approach of the project as well as the overall design methodologies of which the thesis work has been inspired by.*

### 2.1 Project planning

The thesis is carried out during 20 weeks starting in August 2018. The work is documented in this report and the process and results are presented and defended orally at the end of the project.

At the beginning of the project the thesis time frame was distributed over the included parts by estimations of the duration for each phase. A Gantt chart was established to ensure that all activities of the project would get done in time. The Gantt chart has been modified during the thesis work as some activities required more time and focus than others, and due to changes of the project scope. The initial and the final Gantt chart can be found in Appendix A.

### 2.2 Approach

The process was inspired by the *Double Diamond Design Process* introduced by The UK Design Council in 2005 [1], methods described by Ulrich and Eppinger in *Product Design and Development* [2] as well as methods and mindsets proposed in *The Field Guide to Human Centred Design* by IDEO.org [3]. The design process has been performed iteratively and some phases have been overlapping. The processes and methods are described in the next sections and further explained in the beginning of each chapter where applied, together with additional methods used within specific tasks.

### 2.2.1 Double Diamond

The *Double Diamond Design Process* model is divided into the four stages “Discover”, “Define”, “Develop” and “Deliver” which follows a twice repeated divergence-convergence pattern. The adapted model, which is illustrated in Figure 2.1, shows that the first parts of the development process, i.e. the first diamond, is about finding the right problem to solve whereas the second parts implies finding the right solution to the problem addressed [4, p. 220-221].

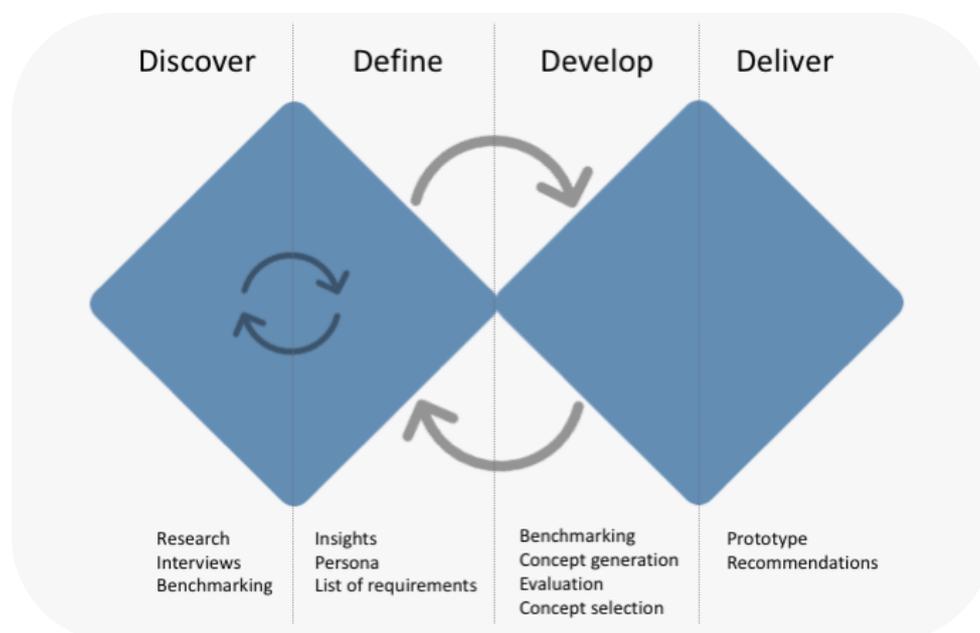


Figure 2.1 The adapted Double Diamond model.

#### 2.2.1.1 Discover

The goal for the first divergent phase of the process is to get a deeper understanding of the problem, usually through user and market research [1].

Meetings were held with employees at SHL to further understand the problem and a brief literature study was conducted to learn more about the product, the market and the target group to design for. Interviews were held with users and relevant stakeholders to identify needs.

### *2.2.1.2 Define*

During the Define phase, the information and insights gathered during the Discover phase are analysed to be refined as problems [1].

Three personas were created based on the research. The personas represent typical users of the target group and helped defining the area to focus upon. Each persona generated needs and requirements that were stated and prioritized.

### *2.2.1.3 Develop*

The Develop phase includes creating concepts and prototypes for testing and evaluation in an iterative process [5].

Concept generation began early during the interview phase. Ideas, preferences and concepts were iteratively discussed and evaluated with users and stakeholders to shape the personas with realistic preferences.

With the personas in mind, more detailed concepts were created through brainstorming and benchmarking. The concepts were further developed and combined to reach a solution that meets a majority of the needs of the target group.

### *2.2.1.4 Deliver*

The last converging stage of the double diamond is the Deliver phase. This phase usually includes final testing and launching the product in the relevant market [5].

Since the storage solution should serve as an accompaniment to a non-specified product, this project ends at a concept stage. One concept was chosen and digitally prototyped to symbolize the functions and aesthetics recommended for a final product. The concept was delivered with a list of recommendations for future development.

## **2.2.2 Ulrich and Eppinger**

*Product Design and Development* by Ulrich and Eppinger [2] consists of product development methods, primarily for engineering and industrial design products. The methods cover the entire process from planning of the project to launching the product on the market described in six different

phases. This thesis methodology has been inspired by parts from Phase 1: Concept Development. The included activities often overlap and iteration are necessary. Every activity follows a step by step procedure where the last step is to reflect on the results [2, p. 7]. The activities have been adjusted to fit the project, however reflections have been applied throughout the development process.

### **2.2.3 The IDEO.org Human–Centered Design Toolkit**

The toolkit introduced by IDEO.org contains methods and step-by-step guides for integrating human-centered design into the product development process. *The Field Guide to Human-Centered Design* covers the entire process from planning of the project to launching a product [3]. In their guide, seven mindsets for a successful human-centered design process are described. Three of them, *Creative Confidence*, *Empathy* and *Iterate, Iterate, Iterate* were used as inspiration throughout the process and helped the team to remain user-focused. Tools for conducting interviews and how to observe users in their home environment were also used.

## 3 Research

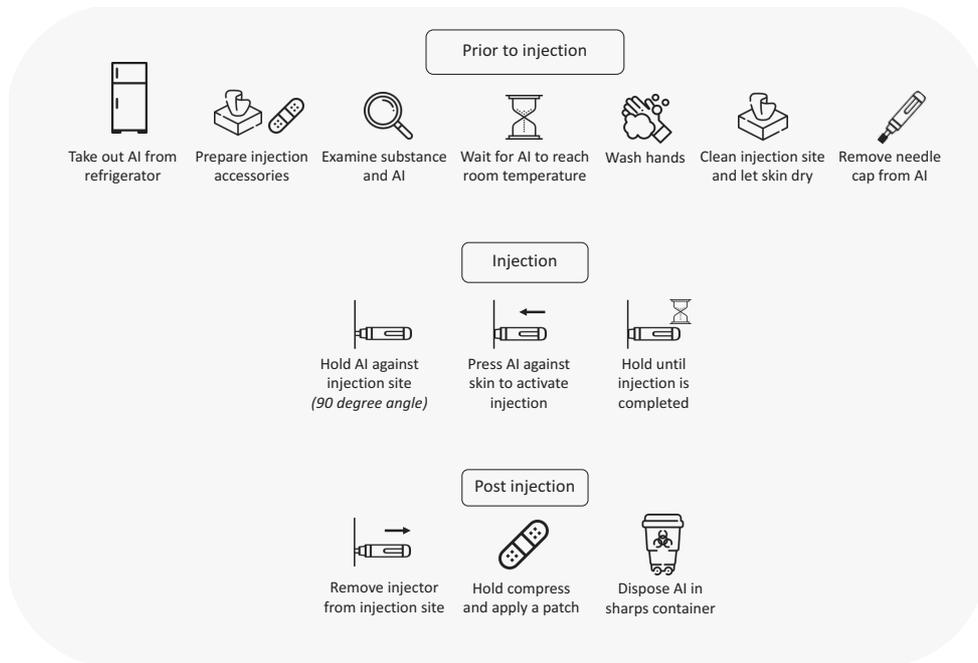
*This chapter provides information about the reusable auto injector concept, therapy areas, medications and the market. The chapter also covers user research through interviews.*

### 3.1 The reusable auto injector concept

This section explains the use of auto injectors. Through an analysis of the reusable auto injector concept, including hypothetical specifications, necessary information for the development process was found.

#### 3.1.1 Task analysis of an injection process with an auto injector

The injection process with a two-step disposable auto injector is illustrated in Figure 3.1. The included activities are based on instruction videos of several devices within MS and rheumatic treatment at *medicininstruktioner.se* [6].



**Figure 3.1 Tasks in an injection process with an auto injector (AI: auto injector).**

### 3.1.2 Analysis of the reusable auto injector concept

SHL's auto injector concept is not on the market yet, therefore most information is classified. From the official information provided by SHL, the concept consists of two units, one reusable unit and one disposable unit containing the drug. The reusable unit holds the mechanics and assembled with the disposable unit it enables a self-administered injection.

The disposable unit must be stored according to storage requirements of the drug contained, while the reusable unit is not as sensitive to temperature changes. Since the reusable unit will be used multiple times, it will be necessary to protect it from the surroundings such as dust and damp to keep it intact.

#### 3.1.2.1 Specifications

Since there is no specified design for the reusable auto injector, the team came up with hypothetical dimensions for both units based on benchmarked products, see Section 3.4.3 and Appendix C. This was done to facilitate the development process, especially when communicating with users and

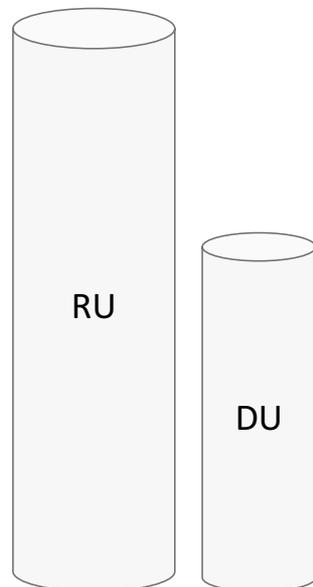
evaluating concepts. The hypothetical specifications are listed in Table 3.1 and Table 3.2, and the units are visualized in Figure 3.2.

**Table 3.1 Hypothetical specifications of the reusable unit.**

<i>Reusable unit</i>	<i>Shape / Metrics</i>
<b>Design</b>	Cylindrical
<b>Length</b>	130 mm
<b>Diameter</b>	35 mm

**Table 3.2 Hypothetical specifications of the disposable unit.**

<i>Disposable unit</i>	<i>Shape / Metrics</i>
<b>Design</b>	Cylindrical
<b>Length</b>	80 mm
<b>Diameter</b>	25 mm



**Figure 3.2. Visualization of the units (RU: reusable unit, DU: disposable unit).**

## 3.2 Therapy areas

The overall target group are patients with long-term and often chronic disorders who need to inject weekly or monthly. This research covers the therapy areas of the project scope, MS and the rheumatic diseases RA and JIA. These are all considered autoimmune diseases.

### 3.2.1 Autoimmune diseases

The human body contains immune cells that produce antibodies. The antibodies are part of the immune system which works as a defence against virus and bacteria. An autoimmune disease is a condition where the body starts producing antibodies that instead attacks specific parts of tissue in the body. There are several diseases that are of autoimmune nature. The cause of these diseases is uncertain and most of them are incurable, however there are drugs that reduce some of the symptoms by suppressing the immune system, hence preventing the attacks [7].

#### 3.2.1.1 Multiple sclerosis (MS)

MS is a chronic inflammation in the central nervous system. MS causes inflammation and scars on the nerve fibres which prevents signals from reaching the brain as they are supposed to. The disease affects people of all ages but is most common to first appear at the ages of 20-40. Women run twice as high risk of getting MS than men. There is no cure but with medication it is possible to slow down the course of the illness and reduce symptoms. Common symptoms are abnormal sensations, fatigue, difficulties with balance, tiredness, stiffness in muscles, decreased eyesight, pain and disturbance in memory and thought activities [8;9]. Optic Neuritis is an inflammation of the optic nerve and a common symptom for MS. The inflammation can lead to blurred vision, reduced colour vision making colours appear darker or faded and pain [10].

The course of the illness varies among the diseased and MS can therefore be divided into four groups or phases presented below.

- **Relapsing-remitting MS**  
About 85-90% of MS-patients first develop relapsing MS. The relapses can last for days up to months. The symptoms can disappear partly or completely between these periods. The time

between the relapses vary greatly among the diseased, from months to years [9, p. 2].

- **Secondary progressive MS**

The majority of the diseased with relapsing-remitting MS starts developing secondary progressive MS after some years with the diagnosis. This condition means that the symptoms gradually increases and worsen even between the relapses. Increased difficulties with walking and muscle weakness are common symptoms of this phase [9, p. 2].

- **Primary progressive MS**

Primary progressive MS is a rare type of MS without relapses. Instead the symptoms and the pain slowly increase over time [9, p. 2].

- **Benign MS**

This type of MS can only be diagnosed after some years with the disease. The disease group includes people that despite many years with the disease have few or no periods with pain and a low neurological impact [9, p. 3].

### 3.2.1.2 *Rheumatoid arthritis (RA)*

RA is a chronic systemic disease that affects about 0,3-1% of the world population. In Sweden, there are about 0,5-1% of the population who are diagnosed with RA. It is more common among women than men and more prevalent in developed countries. The disease often strikes at the age of 20-40 years but is present among all ages [11]. There are certain hereditary genes that could lead to the disease, but there are also other factors involved. The disease affects the joints and the structures around them. RA often starts with inflammation in smaller joints in hands and feet which makes them swollen. Stiffness, increased heat, pain and tiredness are common symptoms and they usually appear on both sides of the body. Over time the disease can affect the joints in knees, elbows and sometimes larger joints like the hip. RA can also cause inflammation in other organs such as the eyes. There is no cure, however there are treatments and physical therapy that can slow down the course of the disease as well as reduce symptoms and pain [11-13].

### 3.2.1.3 Juvenile idiopathic arthritis (JIA)

Every year two hundred children in Sweden are diagnosed with JIA, also referred to as child rheumatism [14]. JIA is a chronic inflammatory disease group that causes inflammations in the joints. The most common type which affects about 60% of the diseased is Oligoarticular JIA. It causes inflammation in one to four joints. Common symptoms of JIA are painful and swollen joints, stiffness in the morning, abnormal crawling or walking and growing less than expected. It can also cause fever, reduced appetite, rashes and problems with feet and hands. The disease progresses with better and worst periods. There is no cure but with treatments and physical therapy it is possible to slow down the disease and reduce the pain. Most people with JIA still have the disease in adulthood, however, for some of them the disease disappears when growing up [14;15].

## 3.2.2 Treatment

### 3.2.2.1 Multiple sclerosis (MS)

MS is treated with medications that slows down the course of the disease, so called disease-modifying drugs (DMDs). Other medications are given to ease the symptoms and in case of severe deterioration cortisone can be taken in a high dose, usually through infusion or tablets. There are a lot of factors that needs to be considered when choosing treatment, for example age, frequency and grade of relapses, risk for worsening of the disease and side effects. For those with relapse-remitting MS the disease-modifying treatments aims to reduce or prevent the relapses. There are biological DMDs which can be either injected, infused or orally taken [16;8].

### 3.2.2.2 Rheumatoid arthritis (RA) and Juvenile idiopathic arthritis (JIA)

The rheumatic diseases, RA and JIA are treated in a similar way. Anti-inflammatory drugs and painkillers are used to reduce the pain and inflammations. The course of the diseases can be slowed down with disease-modifying antirheumatic drugs (DMARDs). The most common DMARD given is methotrexate that can be either injected, infused or taken orally. In cases of moderate to severe conditions and if the treatment so far has not been successful, the patient can be treated with biological DMDs. These are often taken in combination with methotrexate or similar DMARDs. If inflammations occur despite treatment with DMDs, cortisone can be given orally or with injections directly into the inflamed joint to quickly suppress the inflammation.

The treatment of rheumatic diseases also involves physical therapy and home exercising to increase mobility and strength. Patients can also get help from physiotherapists to adjust their environment after their needs and with disabilities tools to facilitate their everyday life [15;17;18].

### 3.3 Medications

The medication research studies biological drugs and more specifically the injectable drugs used in the therapy areas. The study covers storage regulations, usage and package quantities of the drugs. The purpose was to gain knowledge about the treatments to facilitate the communication with the users. The information gathered was also useful when generating and evaluating concepts.

#### 3.3.1 Biological drugs

Biological drugs or biopharmaceuticals, contains an active substance that has been produced from living cells to imitate endogenous substances. Examples of biological drugs are vaccines, antibodies, blood, gene therapies and insulin [19]. In this thesis, biological drugs refer to the biological drugs used within the therapy areas. The liquid substance contains large molecules of proteins and it can either be injected subcutaneously or infused directly into the blood [20;21]. These drugs are expensive which has led to the production of biosimilar drugs which are cheaper but resembles biological drugs [22].

The side effects vary between the drugs. Common side effects are rashes, headache, nausea, flu-like symptoms, severe infections, insomnia, pain, fatigue, allergic reactions and upper respiratory tract infections. There are also risks of depressions, heart failure and other severe conditions [21;23-26].

#### 3.3.2 Handling and usage of injectable biological drugs

All drugs have handling and storing requirements described on a leaflet which is found in the original packaging. Biological drugs are expensive and sensitive, therefore they have special requirements for storage. In common for most biological drugs are that they need to be stored cold and that they

should reach room temperature prior to usage. It is important not to heat the drug, it should gradually warm to room temperature by itself. These drugs are sensitive to light and it is recommended to keep them in their original package until usage. The users are also recommended to keep track of expiration date and to always make sure that the substance is clear and the device is intact before an injection.

There are varieties in sensitivity to temperature changes among the different drugs. Some of the drugs can be stored in room temperature for up to 30 days, while others must be kept cold until the injection occasion. There are also varieties in injection frequency among the drugs, some are injected multiple times per week while others are injected once a month. The most common injection frequency found was once per week. The packaging size also varies and several sizes are usually available for each drug. The drugs can come in single packages or multi packs containing up to 30 injection devices. The most common packaging size found contains four injection devices.

An overview of the registered injectable biological drugs within the therapy areas are found in Table B.1 and B.2 in Appendix B. These covers storage requirements, injection frequency and package quantities for each drug. Observe that Methotrexate is included even though it is not a biological drug since it is often used as treatment for rheumatic diseases, and in combination with biologics [27].

## 3.4 Market

The market research explores forecasts, health trends and market statuses relevant for the medical device business. The search seeks to identify features that can be included in a storage solution which could lead to market opportunities. The market study also covers a benchmarking of existing reusable injectors and their storage solutions.

### 3.4.1 Increasing need for self-treatment

#### 3.4.1.1 *Aging society*

The world population is getting older and older. According to World Health Organization (WHO) our society is predicted to reach a new milestone, shortly there will be more people aged 65 or older than children under age

five. WHO presents that one reason to the aging is a shift in threatening diseases. While infectious and parasitic diseases used to be the major cause of death among infants and children, it is today more common for adults and older people to be diagnosed with non-communicable diseases such as heart diseases and diabetes [28, p.1-10].

In a report published by McKinsey & Co in 2016, they present that the costs for healthcare in Sweden has increased with an average of 4,2 % per year since the millennial. This is 0,9 percentage more than the increase in the BNP of Sweden [29, p.6]. This is not only a result of an increased population, but also a result of the aging society and increased incidence of non-communicable diseases. With these diseases and an aging society, self-treatment will be essential to hold down costs for healthcare. Less people will need to stay hospitalized if they remain mobile through effective medications with medical devices that enables self-treatment.

Self-treatment also means moving the responsibility from the healthcare provider to the patient. To avoid misuse and non-adherence, the device equipment used for self-treatment needs to be intuitive and adaptable to people's everyday life. A storage solution could add value to the user and facilitate the treatment which will lead to decreased costs caused by broken or bad medications and devices or that patients deviates from the treatment.

#### *3.4.1.2 Internet of medical things (IoMT)*

At the same time as the society is aging the technology is moving forward with new innovations. Digital technologies and connected devices will be a way of improving the efficiency of healthcare and decreasing the costs by enabling self-treatment and a more personalized healthcare [29, p.6].

Internet of medical things (IoMT) is the term for digitalisation of healthcare and refers to the technology of connected medical devices to healthcare IT systems. IoMT can help providing both patients and healthcare with information, monitorization and notifications of treatments [30].

The biological drugs used with auto injectors are expensive and it is therefore of interest for several stakeholders to verify that the treatment is successful. By implementing IoMT and by letting the device or the storage solution be connected, it could help monitoring the treatment. It could for example facilitate for the user by giving notifications when it is time to inject, keeping

track of injections and sending information to the healthcare providers, allowing them to follow up on the treatment process.

### **3.4.2 Demand for new innovations**

Even though auto injectors have been present on the market for a long time, the market opportunities for SHL increased after the emergence of biological drugs around the millennial. The drugs enabled new treatment possibilities and auto injectors have now become a standard device, facilitating self-treatment of biologics through its safe and simple design.

The customers of SHL Medical are pharmaceutical and biotechnological companies worldwide that needs devices to deliver their drugs effectively. SHL works close to both the customers and the users to develop innovative solutions meeting their needs. To stay globally leading and attractive on the market there is a demand for new innovations. An innovative storage solution may strengthen the reusable auto injector concept and add value to the concept, making it competitive on the market.

#### *3.4.2.1 Market opportunities*

There is a variety of storage solutions, such as cases and cooling bags, on the market. Some drugs are delivered with an accompanying storage and there are also different solutions to buy externally.

Depending on the design of the storage solution it could open up for new market opportunities. It could either be customized for the reusable auto injector concept and be delivered with the device or designed in a way that pharmacies, disability aid retailers and handbag and luggage shops could include it in their assortment.

### **3.4.3 Benchmarking**

SHL is a market leading company within medical devices. However, there are several companies globally that develop and manufactures auto injectors. Through benchmarking the team learned more about the usage of existing reusable injectors and how they are stored. Benchmarking was done both internally at SHL and externally through internet search and during interviews.

Most of the storage solutions for reusable injectors are included and delivered with the device. There are both hard- and soft cases, soft toiletry bags as well as simple stands that just holds the device without protecting it from the surroundings. In common for most of the benchmarked cases is that they have a specified space for the injection device and additional space that holds needles and an extra disposable unit. Some of the reusable injectors contains multi-dose disposable units. Since the drugs must be stored cold and the device is stored in a case, the whole case is thought to be stored cold. The team has also observed storage solutions that contains space for small ice packs or gel packs, enabling the users to travel with their device while keeping the drugs cold for a short period of time.

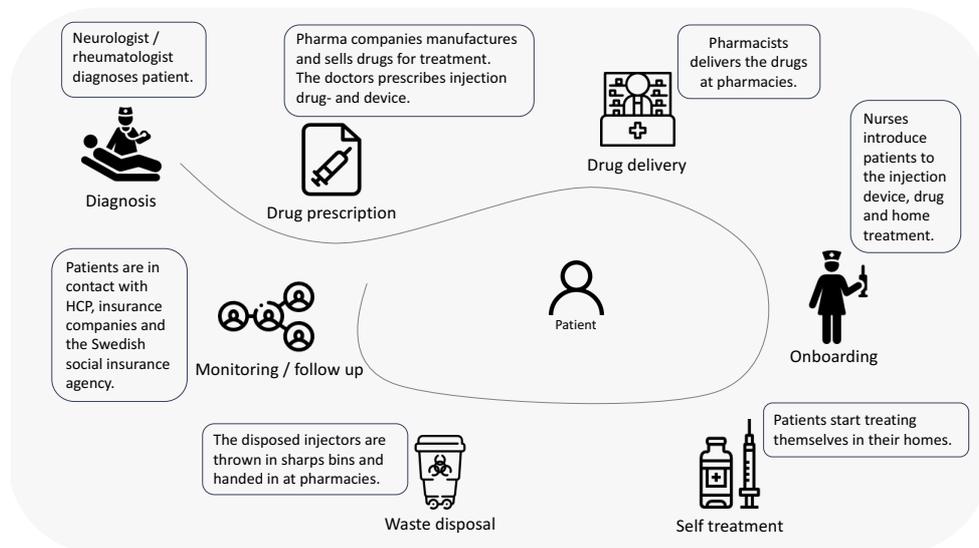
The storage solutions vary in shape and colour. Most of the solutions that the team has observed have logos of the device name or the pharmaceutical company producing the drug printed on the storage. They are typically one- or two-coloured and in similar colours as the device. The biotech products from the internet search are found in Appendix C.

### 3.5 Patient journey

This section presents the steps from diagnosis to self-treatment, information about the stakeholders involved in the treatment and methods and findings from interviews. The purpose of the patient journey was to identify the user needs.

#### 3.5.1 Identification of stakeholders

Patients are in contact with several actors during their patient journey from diagnosis to self-treatment. Each stakeholder possesses knowledge that may contribute to a deeper understanding of the patient experience. By talking to nurses, each activity of the journey was identified among information about the stakeholders involved. The patient journey is visualized in Figure 3.3.



**Figure 3.3** The patient journey from diagnosis to self-treatment (HCP: health care professionals).

### 3.5.1.1 Health care professionals (HCP)

HCP includes rheumatologists and neurologists, nurses, physiotherapists and curators involved in the treatment of a patient with MS, RA or JIA. The rheumatologists or neurologists diagnoses the patient and decides which drug that should be prescribed as treatment. When beginning treatment with injection drugs, the patient has an onboarding meeting with a nurse. This is to learn how to inject and gain confidence in injecting at home. Apart from onboarding, sampling and providing the patient with information about the treatment, the nurses also coordinates the contact between patients and other HCP.

### 3.5.1.2 Pharmaceutical companies

The pharmaceutical companies develop, manufactures and sells the drugs. They control which products that are available on the market and conducts research within the therapy areas that are considered profitable. It is in the interest of the pharmaceutical companies that their drugs are used in a correct way to ensure that the drugs are considered efficient and reliable by other stakeholders. This is one reason to way they sometimes offer storage solutions for their drugs. The companies are not involved in prescription of drugs, however they are providing the HCP with information about their products so that the doctors can decide what drug to prescribe for each patient.

### 3.5.1.3 Pharmacies

The prescribed drugs are collected at pharmacies by the patient. The pharmacists have contact with patients on a regular basis and they have the responsibility of providing information about the drugs that they hand out. Pharmacies also receive and take care of disposed injectors and syringes as well as giving out sharps bins to patients.

### 3.5.1.4 Swedish social insurance agency

The Swedish Social Insurance Agency is responsible for compensation to people with illnesses, for example when patients have to be on sick leave due to their disease. Rheumatic diseases is the disease group that causes the highest society costs in terms of healthcare and social insurance expenses [31]. To lower these costs, it is of interest to the insurance agency that treatments are performed correctly and that the medications are handled in the right way. Unnecessary costs can occur through non-adherence to treatment and waste of drugs or non-functioning drugs due to bad handling.

## 3.5.2 Interviews

Interviews were held with users of injectors, nurses and pharmacists to gain knowledge about the lifestyles, needs and demands of the target group. The interviews were designed with inspiration from the step-by-step guides, *Interview* and *Expert interview* described in *The Field Guide to Human-Centered Design* [3, p. 39-40, 43]. The approach for the interviews varied between the different groups. Semi-structured interviews were conducted with nurses and users to retrieve qualitative data. Detailed descriptions of the interview methods are found in each section.

### 3.5.2.1 Health care professionals (HCP)

Although HCP includes several different professions, a majority of the patient contact is managed by nurses. Therefore, the team interviewed four nurses about their patient- and injection device experience.

#### 3.5.2.1.1 Method

Three interviews were conducted, two with MS-nurses (N2 and N3, N4), and one with a children's rheumatology nurse (N1). N1 and N2 works at the Karolinska Institutet in Stockholm and N3, N4 works at the University Hospital in Lund. All interviews were held in person at the hospitals. The contacts were established through email requests and phone calls.

All interviews were semi-structured and an interview guide with prepared questions was used. The guide is found in Appendix E.1. One of the team members was conducting the interviews while the other team member was observing, recording and taking notes. During the interview with N3, N4, the nurses demonstrated one commonly used injection device together with its accompanying belongings. Advantages and disadvantages of the product as well as other devices and storage solutions were discussed.

### 3.5.2.1.2 Key findings

The key findings discovered during the interviews with HCP are presented in Table 3.3.

**Table 3.3 Key findings from interviews with HCP.**

<i>Key finding</i>	<i>Insight</i>
<b>Injection treatment of MS is phasing out</b>	<ul style="list-style-type: none"> <li>○ Treatment with infusion and tablets is more common than with injections.</li> <li>○ Almost all newly diagnosed MS patients starts their treatment with infusion or tablets at the hospitals where the nurses work.</li> <li>○ It is getting more common for patients who injects to switch to infusion or tablets when switching drugs.</li> </ul>
<b>Discreet design</b>	<ul style="list-style-type: none"> <li>○ No company logos.</li> <li>○ Neutral colours.</li> <li>○ The storage should not look medical/clinical.</li> </ul>
<b>Simple and intuitive design</b>	<ul style="list-style-type: none"> <li>○ Easy access to the device.</li> <li>○ Details adapted to fit users with disabilities, for example reduced fine motor and sensory problems.</li> <li>○ Users should not have to learn how to use both the injection device and a storage solution.</li> </ul>
<b>Users struggles with cooling requirements</b>	<ul style="list-style-type: none"> <li>○ Temperature worries frequently discussed topic.</li> <li>○ Cooling solutions should be reliable.</li> <li>○ Planning and insufficient solutions when travelling leads to non-adherence.</li> </ul>

### 3.5.2.2 Pharmacists

Pharmacists have frequent contact with users of auto injectors. They answer questions and helps with additional drugs for reducing the side effects. To learn more about their experience and to see whether they had any storage solutions in their assortment, three pharmacies were visited.

#### 3.5.2.2.1 Method

The team visited Lloyds Apotek Torsplan, Stockholm, Apotek Hjärtat Odenplan, Stockholm and Apoteksgruppen Bua, Varberg. All pharmacies were visited spontaneously and interviews were held without any interview guide. The team focused on questions regarding drug collection, commonly asked questions by patients, perceived worries among patients, their experience with storage solutions and whether they had any solutions in their assortment.

#### 3.5.2.2.2 Key findings

The key findings discovered during the interviews with pharmacists are presented in Table 3.4.

**Table 3.4 Key finding from interviews with pharmacists.**

<i>Key finding</i>	<i>Insights</i>
<b>Demand for cooling solutions</b>	<ul style="list-style-type: none"><li>○ Users are asking for cooling bags.</li><li>○ The visited pharmacies do not have cooling solutions in their assortment.</li></ul>
<b>Maximized drug collection</b>	<ul style="list-style-type: none"><li>○ Most users want to collect drugs for three months of use which is maximal amount allowed in Sweden.</li></ul>
<b>Waste uncertainties</b>	<ul style="list-style-type: none"><li>○ Users handle their waste differently and sometimes incorrectly.</li><li>○ Pharmacists experience that there are no clear rules. Uncertainties prevails among users and pharmacists.</li></ul>

### 3.5.2.3 Users

In this section, users refer to people diagnosed with MS, RA and JIA who are injecting, have been injecting or are going to start injecting. Apart from having various disease symptoms and treatments, the users are people with different lifestyles, personalities, needs and worries. Interviews were held

with users from the three different therapy areas of various ages and from different geographical locations.

#### 3.5.2.3.1 Method

Eleven semi-structured interviews were held with people diagnosed with MS or a rheumatic disease with the following distribution:

- Three users with JIA
- Four users with RA
- Three users with MS
- One user with unknown rheumatic disease

Ten of them were living in Sweden and one of them usually lives in Sweden but was during the interview in Colombia for six months as an exchange student.

The interviewees were found through contact ads at Karolinska, in Facebook groups for people with rheumatism and MS and through the team's network.

Four of the interviews were held in the home of the interviewees, four were held in person at libraries and cafes and three of them were held through Skype and phone calls.

An interview guide was used as guidance, found in Appendix E.2. One of the team members was in charge of asking the questions while the other one was observing, taking notes and handling the audio recording. The questions were held open and supplementary questions were asked when a question was unanswered or when the team picked up on something interesting. The interview guide was designed so that the interviewee was unaware of what kind of product the team was developing until the last part of the interview. This was to avoid influencing the responses.

The last part during each interview addressed storage solutions and potential features to include. During the first interviews, existing storages were shown and the interviewees were told to examine them and explain what they liked and disliked about each storage. These were not only storages for injection devices but also other kinds of cases and toiletry bags. Later on during the interview stage, early sketches of ideas were discussed and refined iteratively.

During the interviews that were held in the home of the users, guided tours were performed inspired by the step-by-step guide *Guided Tour in The Field Guide to Human-Centered Design* [3, p. 64].

### 3.5.2.3.2 Key findings

The key findings discovered during the interviews with users are presented in Table 3.5.

**Table 3.5 Key finding from interviews with users.**

<b>Key finding</b>	
<b>Injection satisfaction</b>	<ul style="list-style-type: none"> <li>○ Users are overall satisfied with the injection process.</li> </ul>
<b>Store RU with other medications and belongings, adjacent to injection location</b>	<ul style="list-style-type: none"> <li>○ Some users prefer to store it easily accessed for example on the kitchen table while others prefer to hide it.</li> </ul>
<b>Safe environment for RU</b>	<ul style="list-style-type: none"> <li>○ Observations found that users do not expose their devices to any hazardous surroundings.</li> <li>○ Some users express a wish for protection of the device when travelling.</li> </ul>
<b>Various waste habits</b>	<ul style="list-style-type: none"> <li>○ Some users throw their disposed injectors in the trash while others collect the waste and hands it in at the pharmacies.</li> <li>○ Sharps bins are used to a small extent. Users would not like to include a waste bin in the storage solution.</li> </ul>
<b>Cooling requirements limits users</b>	<ul style="list-style-type: none"> <li>○ Travelling with drugs is considered troublesome.</li> <li>○ Some users skip or change date of injection when travelling to avoid bringing the medications.</li> <li>○ Some also choose to go on shorter trips or avoid travelling. Two of the users realised during the interviews that they were unconsciously limited to travel.</li> </ul>
<b>Temperature worries</b>	<ul style="list-style-type: none"> <li>○ Users worry about the temperature of the drugs, mainly when travelling but also when storing at home.</li> <li>○ When unsure of the temperature, users would like to verify the temperature but are afraid to open the cooling bags to let heat in.</li> <li>○ Users would like temperature feedback to ensure that the drug is not too cold or too warm.</li> </ul>

**Users are used to rechargeable devices**

- Rechargeable devices are commonly used among the users.
- Bringing a charger and finding a power outlet is not experienced as an obstacle.

**Demand for flexibility**

- The needs vary among the users and each individual also has different needs for different occasions.
- Hard to find a storage solution that suits all users during all occasions.

**Size matters**

- Some users are willing to compromise regarding what to store to get a smaller solution.
- Other users are willing to compromise regarding size to get a functional solution.
- The definition of size is subjective and reflects the injection frequency, size of their device and the amount of other medications.
- Even though it is recommended to store drugs in the original package, some users store them without it to save space.

**Discreet design**

- Users dislike pharmaceutical company logos as well as medical and clinical looks.
  - Neutral and dark colours are preferred.
  - The storage solution should resemble the user's personal belongings to blend in.
-

## 4 Conclusions of research

*This chapter covers important conclusions from the research and provides additional delimitations and assumptions established before further concept generation.*

As stated in the initial brief, the thesis aims to develop a storage solution and to search for extra features that can add value to the users. To do so, it was important to not only consider storage of the reusable unit. The user research showed that most users are satisfied with the injection process and their devices. Most of the worries during the injection process were related to pain and to the inconvenience of when an injection occasion collides with everyday activities.

Possibilities of creating value in the storage solution was instead found by observing and considering the entire lifestyle of the users, both related and unrelated to their diseases. It was found that users are limited to travelling and when they do travel, it takes a lot of planning before they go. These limitations were identified to mainly be caused by the cooling requirements of the drugs. Indications of that was that some users chose to skip injections while away, some chose to go for shorter vacations to avoid injections during the stay and some realized during the interviews that the reason to why they do not travel anymore might be related to their treatment. The research generated a lot of useful information for the ideation phase and two main conclusions forms the basis for further development of concepts.

### 4.1 Demand for cooling solution and temperature feedback

As mentioned above, a common worry and limitation among the users was travelling with drugs that must be stored cold. A storage holding both the reusable unit and disposable units, and that keeps the drugs cold, could add extra value to the users.

When using cooling bags, worries regarding the inside temperature were expressed among the users. The cooling bags used by the interviewees did not have any temperature feedback and the users had to choose between opening the bags to check the temperature while letting warm air flow inside or to act passively and hope for the best. A cooling solution should therefore have temperature feedback so that the users can ensure themselves that their drugs are stored in the right temperature. This feature makes a cooling solution more reliable.

## 4.2 Need for flexibility

The interviews revealed that all the eleven users had different lifestyles, preferences and needs. Their needs also vary from occasion to occasion. The same user can have some needs when being at home and other when transporting their injection devices. Another insight was that even though the users have one out of three diseases, their amount of medications, injection frequencies and physical impact vary. It is therefore of interest to consider a flexible solution that could suit most users.

## 4.3 Additional delimitations and assumptions

The research showed that even though IoMT is successfully transforming the health care through connected medical devices, a storage solution is not recommended to be connected with the purpose of monitoring treatments. It is recommended that the injection treatment is independent of the storage solution since using it should be optional. Also, focus should be on learning the injection process and if monitoring through connectivity is desired, it is probably more efficiently implemented in the device itself.

The medical research and findings during the interviews with HCP and pharmacists showed that the biological drugs are recommended to be stored in their original package. Despite the recommendation, users sometimes take them out to fit them in the refrigerator or in personal bags and cooling bags when travelling. It was revealed that some users are willing to remove the original package to free up space. Because of this, and since the package design for the disposable units is not specified, the units will be treated as

individual objects without any packaging if developing a solution where they are included.

# 5 Personas

*This chapter introduces three personas. The personas represent typical users from the target group created based on the interview material from the patient journey research.*

## 5.1 Method

A persona is a fictitious character created to represent users in a target group. Personas represent the needs, worries, goals and feelings of a typical user. Personas are detailedly described in a way so that they can be considered as real humans and ideal users of the product. Personas are a reminder of that the product will be used by people with needs and are useful to ensure a human-centered design.

Creating personas starts with interviewing people from the target group and collecting qualitative data about the users. By analysing the information and identifying behaviour patterns, personas can be created from individuals with common behaviours and needs. The personas should then be assigned a name, age, pictures and situations describing the personas goals with the product. It is important to use the real data collected from the interviews when describing needs, preferences and wishes [32, p.267-269].

Through the interviews held in section 3.5.2, qualitative data was collected. The team chose to first analyse the data by establishing eleven characteristics with individual scales graded in relation to the interviewees. The characteristics were chosen from observations of differences and similarities during the meetings with the users. To identify behaviour patterns, the interview material was carefully reviewed and all users were graded on each scale. The material can be found in Appendix F. The users were then clustered as much as possible, and together with additional insights and observations from the interviews, the three personas came alive.

Each persona generated requirements of the product that was later used for evaluating the concepts.

## 5.2 Julia

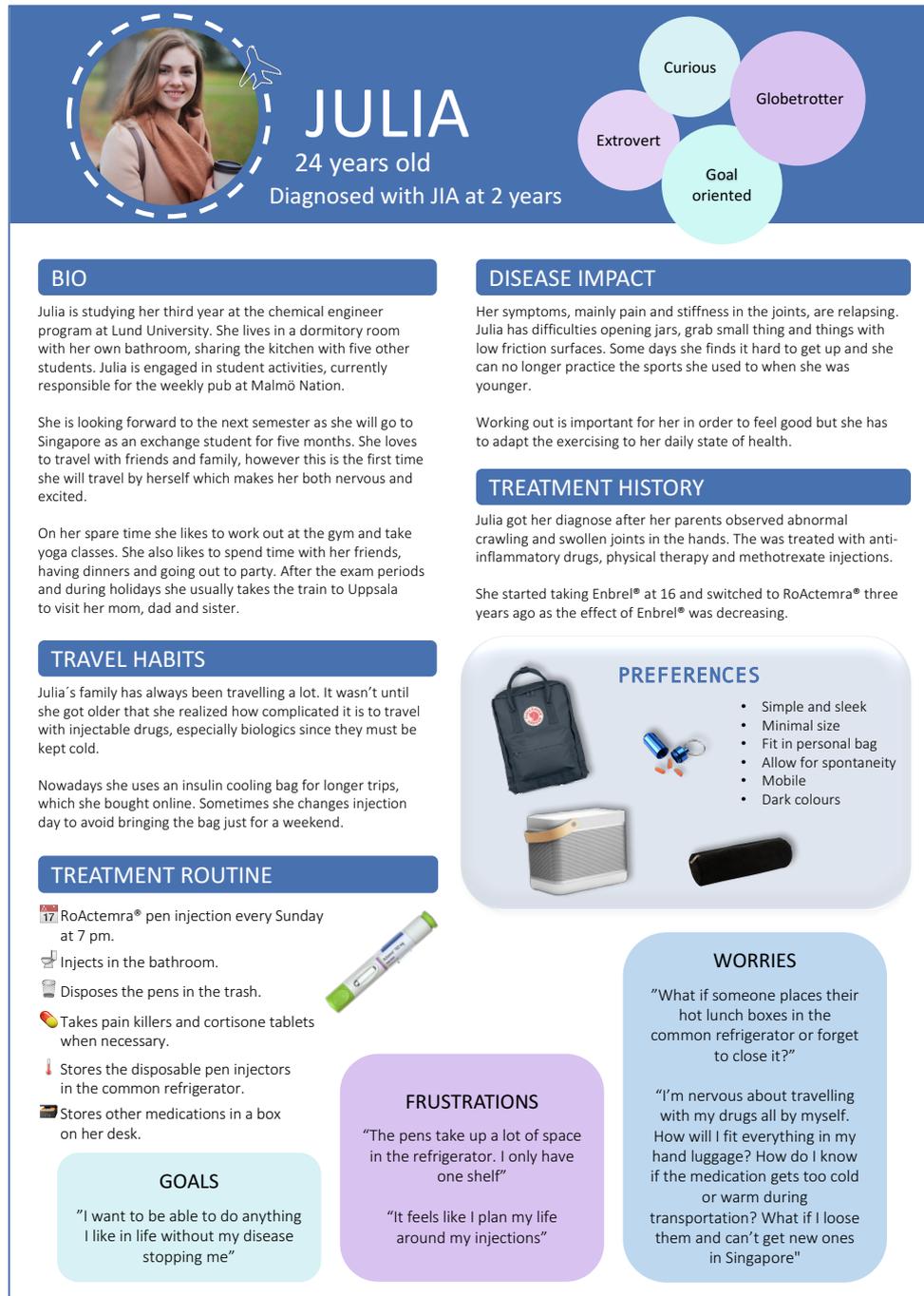


Figure 5.1 The persona Julia.

### 5.2.1 List of requirements

The generated requirements of Julia are presented in Table 5.1.

**Table 5.1 Julia's list of requirements.**

<i>No.</i>	<i>Requirement</i>
1	Cooling storage at home
2	Cooling storage for shorter trips
3	Cooling storage for longer stays
4	Easy access to injection device
5	Easy to open / close
6	Exterior material with friction for good grip
7	Aesthetics resembles personal belongings (discreet design)
8	Allowing for spontaneity

## 5.3 Rakel

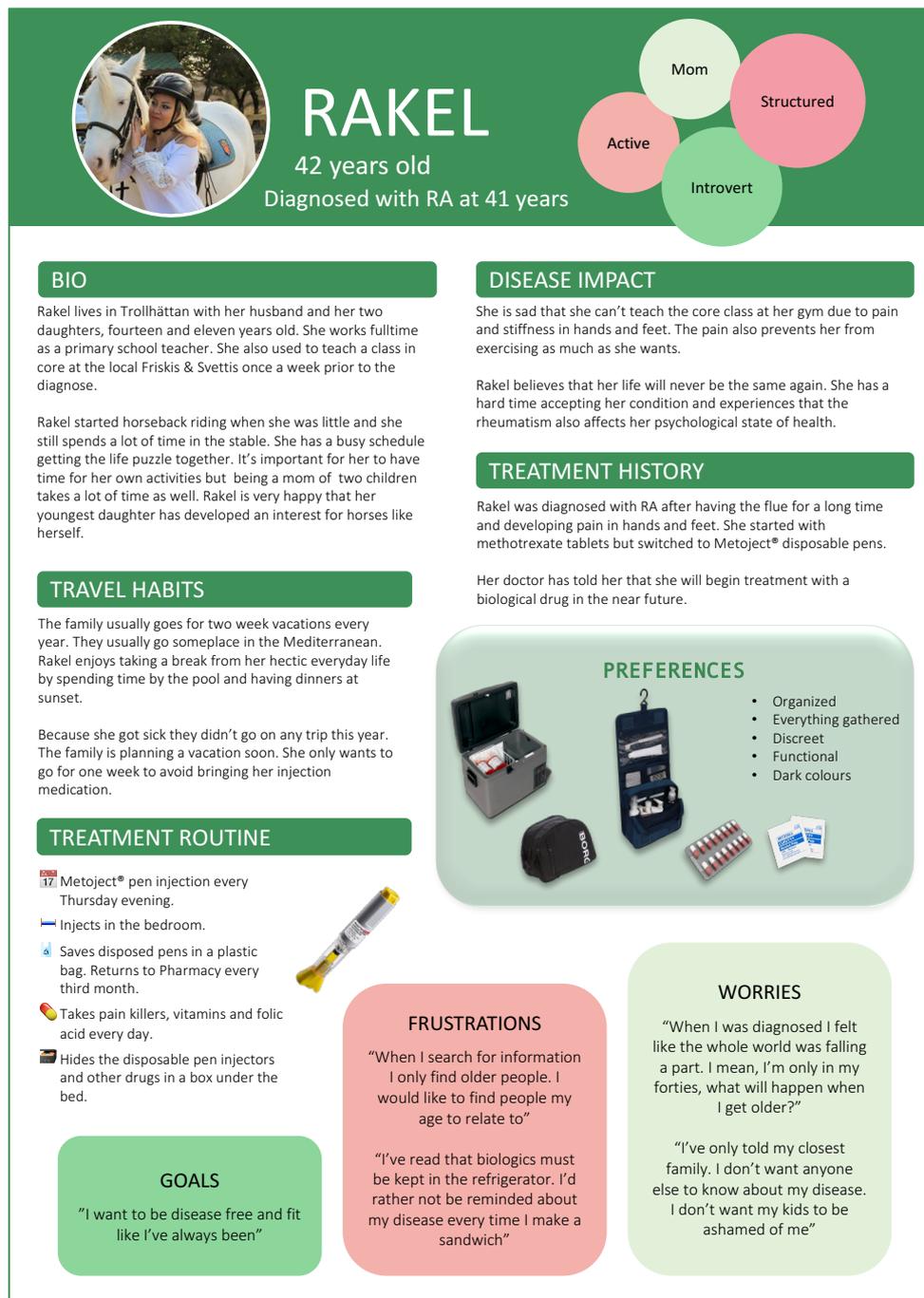


Figure 5.2 The persona Rakel.

### 5.3.1 List of requirements

The generated requirements of Rakel are presented in Table 5.2.

**Table 5.2 Rakel's list of requirements.**

<i>No.</i>	<i>Requirement</i>
9	Cooling storage for home
10	Space for accessories and additional drugs
11	Discreet design
12	Possible to hide at home
13	Cooling storage for two-week vacation

## 5.4 Mona



Figure 5.3 The persona Mona.

### 5.4.1 List of requirements

The generated requirements of Mona are presented in Table 5.3.

**Table 5.3 Mona's list of requirements.**

<i>No.</i>	<i>Requirement</i>
14	Possible to bring in personal bag to activities
15	Cooling function for car trips
16	Fit pill organizer when travelling
17	Aesthetics resembles personal belongings (patterns, exclusive look)

## 5.5 Reflections

The personas are only based on the eleven user interviews conducted during the patient journey research. A majority of the interviewees were found through posts on Facebook and all of them have chosen to participate and to contribute with their experiences. The personas might therefore not cover the needs of people who are unwilling to talk openly about their diseases.

All of the personas were created as women which is both based on that the interviewed users were all women except for one and that it reflects the diseases prevalence. All three therapies are more common among women than men.

The team wanted the personas to represent all three therapy areas. It is important to keep in mind that, for example, not all users with MS are 60 years old like Mona or that only users with JIA likes to travel the world. However, the team is very satisfied with the personas and experience that they represent the interviewees in the target group very well.

# 6 Ideation

*This chapter covers the creative concept generation phase, benchmarking of cooling storages and evaluation of concepts towards the requirements.*

## 6.1 Method

During the interviews, early concepts were generated through brainstorming and evaluated iteratively with the users through sketches, specific questions and by letting the users describe personal storages that they use. The team tried to go broad during the first concept generation phase to get an insight of what the users liked and disliked, as well as to start a discussion and encourage the users to broaden their perspective. Concepts were screened through iterations which resulted in a clear picture of needs and preferences at the end of the interview phase.

To investigate in the possibilities for a cooling solution a second benchmark was performed through searching the internet for existing solutions and cooling techniques, and by using the information received during the interviews. Inspiration was also found when searching for creative ways of storing things and for products preferred by the personas.

Based on the preferences and with inspiration from the benchmark of existing cooling solutions, the team further developed the concepts through brainstorming to meet the needs of the personas. The concepts were then evaluated through three concept scoring matrices, one for each persona. The method was inspired by the concept scoring matrix proposed by Ulrich and Eppinger in *Product Design and Development* [2, p.154-156]. The requirements of the personas were weighted and each concept was rated from 0-5 according to how well it would meet the requirements, where 5 means meeting them very well and 0 means not meeting them at all. Note that some of the requirements could not be evaluated at this stage, however the non-evaluated requirements can be met in any of the concepts.

Another round of brainstorming was performed after discussing the outcome of the evaluation, this time with the purpose of combining characteristics from the concepts and with focus on the design and more detailed functions of the storage solution. This resulted in a concept that the team chose to further develop.

## 6.2 Benchmarking of cooling solutions

In common for the personas are temperature worries of the drugs while travelling and the limitations due to cooling requirements. Some users also worry about the temperature when storing the drugs in the refrigerator at home. Since the drugs must not freeze and most of them requires to be stored at a temperature of 2-8°C, there is a high demand for safe cooling and reliability. The benchmark aimed to generate ideas for possible solutions without evaluating how reliable and effective they are. The benchmarked products from the internet search are found in Appendix G.

When starting the injection treatment, some users receives a cooling bag similar to ordinary cooling bags for food, with their device. These are often made with soft fabrics and isolation and are sometimes delivered with ice packs or gel packs. The ice packs and gel packs must be frozen prior to usage to achieve a cooling effect. The observed cooling bags varies in size and colours and while some had special pockets for the ice packs, others were designed so that the medicine packages came in direct contact with the ice packs. The latter was perceived as an unreliable solution, hence making the users add extra isolation around the drug packages, for example by wrapping them with a towel.

When searching the internet, most of the solutions found are designed for insulin and are soft cooling bags keeping the drugs cold by using ice packs. As an example, the online shop *ReumaShop.se*, which has a collaboration with the Swedish Rheumatism Association, only offers soft cooling bags and sets of extra ice packs and gel packs.

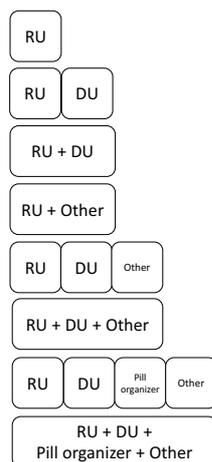
Unlike the solutions observed during the interviews, the internet search showed that many cooling solutions on the market are more customized for medical use, with several compartments holding devices and accessories.

The bags have different capacities of cooling effect, where the solution with the longest cooling time found claims to hold a temperature of 2-8°C for up to 36 hours in an ambient temperature of 24°C.

The team also discovered different portable electronic cooling solutions. The coolers work as small refrigerators and comes with power cables, car adapters and sometimes external batteries. As an example of size, one mini refrigerator is 207 mm x 94 mm x 91 mm and holds between 3-5 insulin pens. In the electronic coolers, additional features are often integrated such as thermometers and LED displays.

### 6.3 Storage decomposition

One finding from the research was that users want their storage to be of minimal size. However, people's definition of small varies greatly. Reason are that the users have different injection frequencies, devices and amounts of additional medications. The personas express different preferences of what they would like to include in a storage of the reusable unit to keep it as small as possible, yet functional. The preferences were divided into modules and then combined to compose potential solutions. The different solutions are illustrated in Figure 6.1. Note that there are more possible solutions, thus these are the ones that the team thought would suit the personas the best.



**Figure 6.1 Potential combinations of storage solutions (RU: reusable unit, DU: disposable unit).**

## 6.4 Concept generation

### 6.4.1 Early concepts

A selection of early sketches is presented in Figure 6.2.

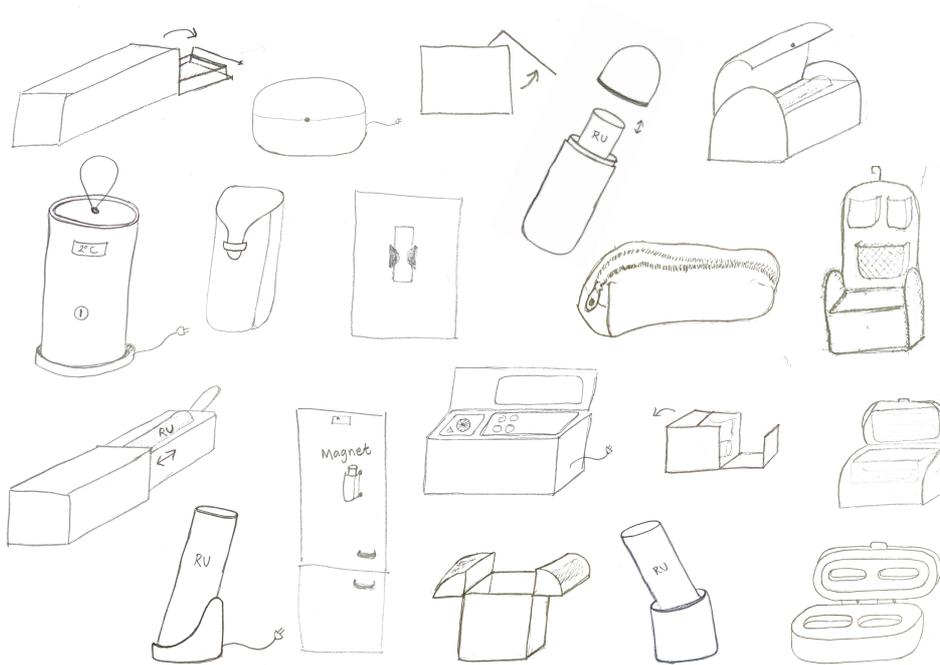


Figure 6.2 A selection of early sketches.

## 6.4.2 Concepts

After exploring possible combinations of what to store as well as cooling solutions, further development of previously iterated ideas resulted in four concepts. The concepts represent the overall functions and contents, rather than details and design. Sketches and descriptions of each concept are presented below.

### 6.4.2.1 Concept A – All in Two

All in Two lets users move all their medications and injection accessories to one single storage. This solution has two compartment modules. One works as a refrigerator, that can keep injection drugs for three months of use for people injection once every week. The other compartment has a pocket for the reusable unit, keeping it fixed to protect it from hits and shakes. This compartment also holds other medications in a robust way, allowing it to fit many types of packages. The cooling compartment is run by electricity when plugged in with a cord. The two modules can be attached with each other, allowing for flexibility. It is possible to travel with All in Two as one package of drugs could be replaced with an ice pack. The cooling solution is featured with a temperature display. The concept is illustrated in Figure 6.3.

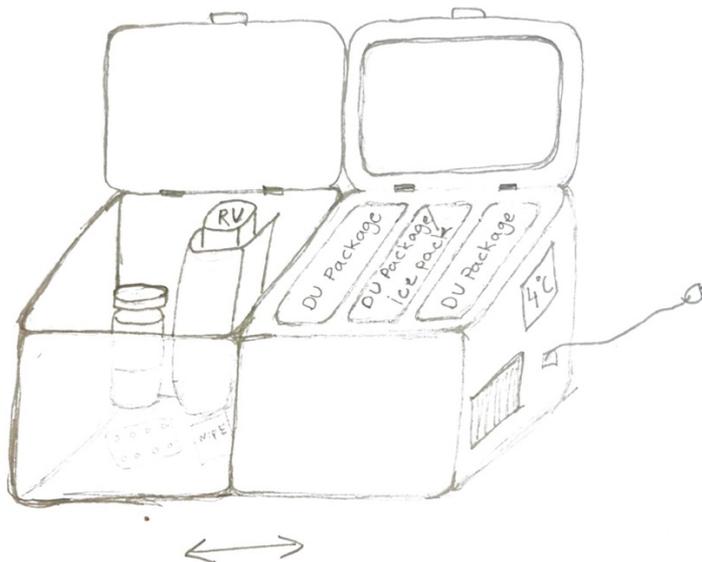


Figure 6.3 Sketch of Concept A - All in Two

#### 6.4.2.2 Concept B – Cool Organizer

Cool Organizer is similar to an ordinary cooling bag. With customized compartments, one for the reusable unit and injection disposable unit packages and one for a pill organizer, injection accessories and smaller medication packages such as blister packs, this storage enables for easy transport of medications. Since the fitting is customized, the size can be kept small in relation to ordinary cooling bags. Cool Organizer holds injection drugs for one to two months of use for a person injecting once every week. Two ice pack compartments surround the drugs with isolating layers in between, preventing the drugs from freezing. With the right ice packs, it could keep the medication cold for more than 24 hours, based on benchmarked products. The cooling solution is featured with a temperature display. The concept is illustrated in Figure 6.4.

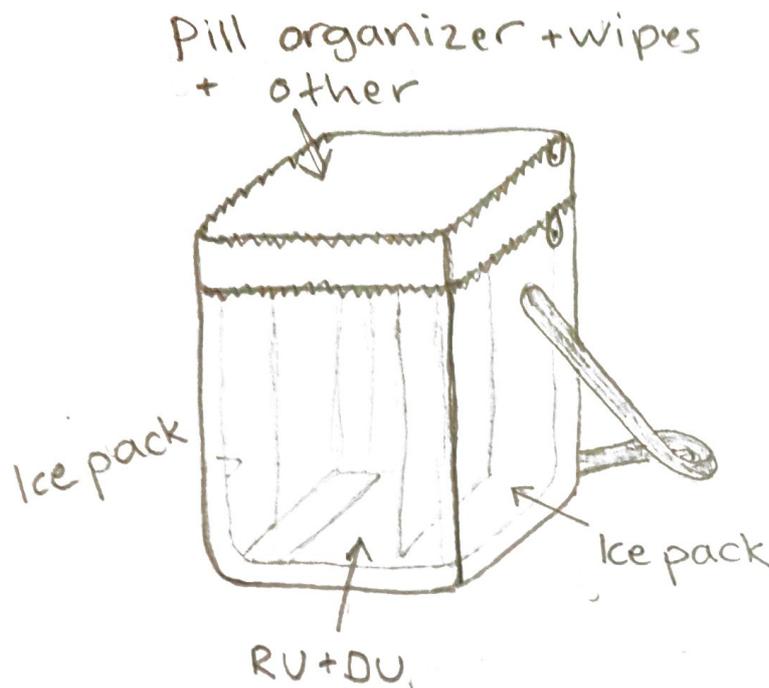


Figure 6.4 Sketch of Concept B – Cool Organiser

### 6.4.2.3 Concept C – Cool for the Weekend

Cool for the Weekend is a portable mini refrigerator run by electricity. An internal and/or external battery enables safe transportation of the injection drugs. The storage has an integrated space for the reusable unit, which can be reached without having to open the cooling compartment. The storage can hold injection drugs for two injections. The cooling solution is featured with a temperature display. The concept is illustrated in Figure 6.5.

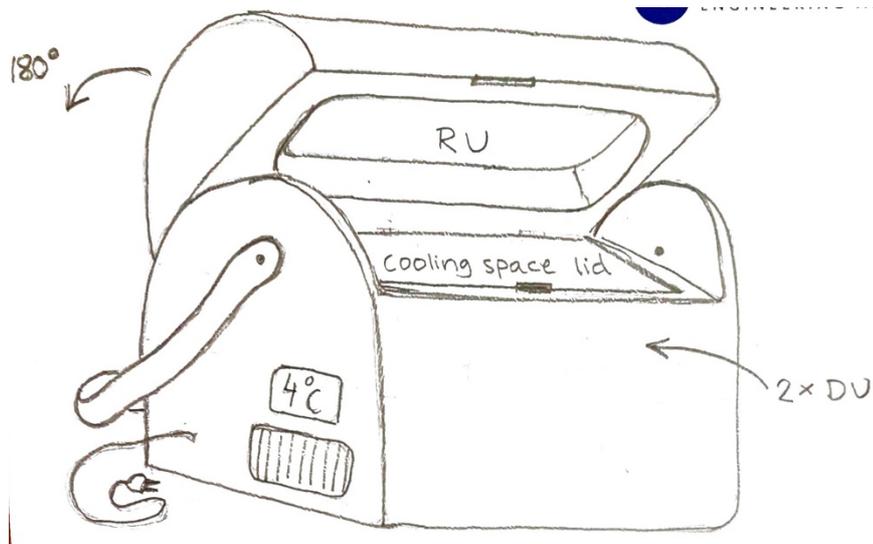


Figure 6.5 Sketch of Concept C – Cool for the Weekend

#### 6.4.2.4 Concept D – In Case of Injection

In Case of Injection is a simple and discrete case that holds the reusable unit and one disposable unit, and a limited amount of injection accessories. The case keeps the reusable unit protected from its surroundings when storing it at home. It is also suitable to bring when an injection occasion collides with an activity, or for shorter trips if the drug can be stored in room temperature for a certain period of time. The concept is illustrated in Figure 6.6.

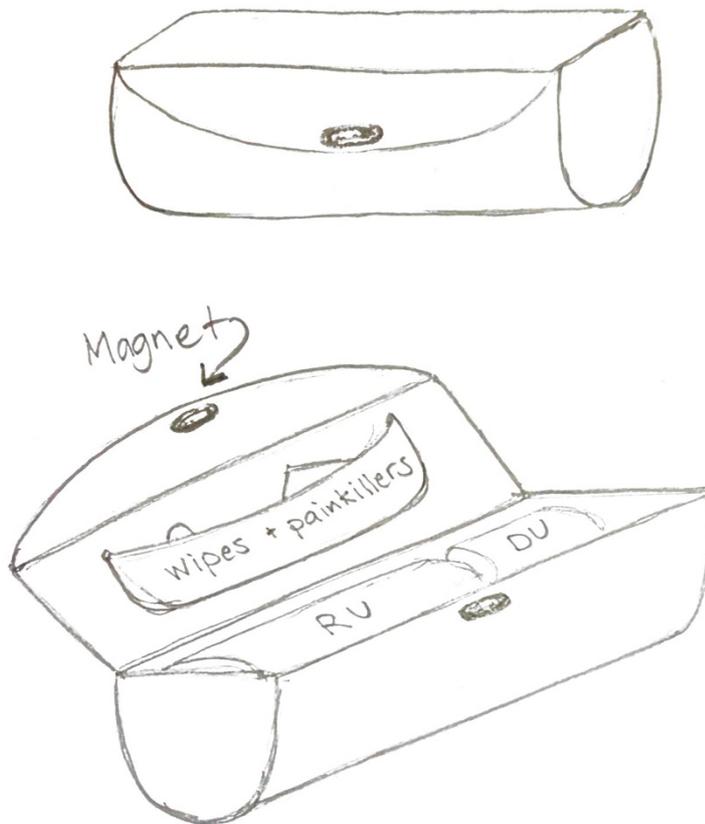


Figure 6.6 Sketch of Concept D – In Case of Injection

## 6.5 Evaluation towards the requirements

The concepts were evaluated in relation to the requirements. The evaluation is summarized with the concept ranking from 1-4 for each persona in Table 6.1, where 1 is the concept with the highest score. The detailed concept scoring matrix is found in Appendix H.

**Table 6.1 Ranking of concepts.**

<i>Persona</i>	<i>Concept A</i>	<i>Concept B</i>	<i>Concept C</i>	<i>Concept D</i>
<b>Julia</b>	2	3	1	4
<b>Rakel</b>	1	3	2	4
<b>Mona</b>	3	1	4	2

## 6.6 Combination of concepts and further development

The advantages and disadvantages of the four concepts were discussed with the users in mind. The personas all have different needs and none of the concepts felt like an outstanding winner. Concept B was screened out since it does not protect the reusable unit when storing it at home and is also not considered very innovative. A new flexible and modular concept was developed based on the strengths of the remaining three concepts stated below.

- Concept A is modular which allows users to choose which parts to use. It has an electronic cooling function and it holds a large amount of drugs which makes it suitable as a substitute for the refrigerator.
- Concept C has an attractive size for transport of a small amount of drugs, keeping them cold through electronic cooling with a power cord or battery.
- Concept D protects the injector without taking up extra space. It could be stored in almost any place and is perfect to bring when an injection collides with an activity, if the drug allows for it.

### 6.6.1 Concept E

The brainstorming resulted in a new concept consisting of two modules that can be used separately or in combination by attaching them to each other. One module, a case similar to Concept D, holds the reusable unit and one disposable unit. The other module is an electronic cooler that holds four disposable units. With four units, the solution will be kept small enough to be attractive to the users, yet allowing for home storage of smaller amounts. The cooling module is featured with a temperature display. Sketches of the concept ideas are found in Figure 6.7-6.8.

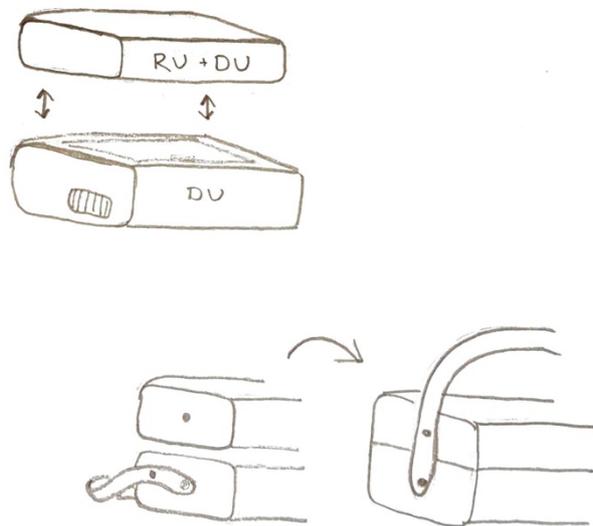


Figure 6.7. Idea sketches for Concept E.

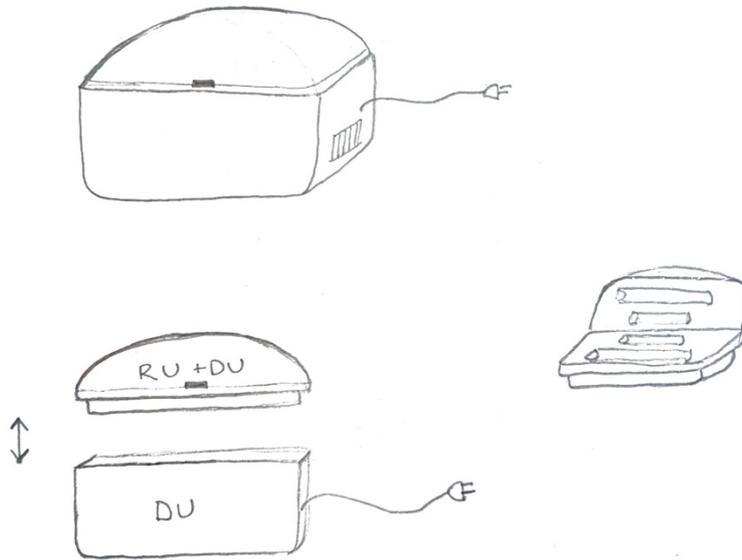


Figure 6.8. Idea sketches for Concept E.

## 6.7 Reflections

The iterative concept generation and evaluation during the interviews was an effective way to eliminate unpopular ideas and to develop ideas with potential through instant feedback. Even though similar preferences were found among the users, finding a solution that suits all users at all occasions was hard. It is possible that one of the other concepts would be more suitable for one of the personas than Concept E. However, the team decided to search for a concept that suited all three to some extents rather than a concept only appreciated by one of them. A modular solution could have the potential to fulfil a greater amount of the requirements since it allows for flexible usage.

## 7 Final concept

*This chapter presents the chosen concept with a description and images of the digital prototype. The chapter also includes an evaluation of the concept towards the requirement of the personas.*

### 7.1 Method

Concept E represents an idea of how the storage solution could work. Refinements were made through sketches and discussions. The dimensions were estimated based on the hypothetical specifications of the reusable and the disposable unit as well as benchmarked products to give an idea of the size. Functions and details such as opening/closing the case, attaching/detaching the case and easy access to the units have been considered but not fully implemented, nor evaluated. The final concept was digitally prototyped and rendered in SolidWorks. The concept was then evaluated towards the requirements of the personas. Finally, a list of recommendations for further development of the storage solution was established.

### 7.2 Description of concept

The concept consists of two parts, a case and an electronic cooler. The case holds the reusable unit, one disposable unit and has an extra compartment with space for, for example painkillers. The case is opened as a clam shell giving the users easy access to the devices. With a tight seal the case protects the reusable auto injector from the surrounding. Each unit has its own dimensioned recess keeping them from moving around when carrying the case and the hard shell in combination with the shock absorbing inner padding protects the units against unwanted impacts.

The electronic cooler has a compartment that holds four disposable units that are placed in dimensioned recess. The recesses keep the drugs in place to prevent damage. The drugs are stored at the required temperature and has a built-in thermometer connected to an exterior display showing the temperature.

The team chose a dark blue colour for the solution since blue is a neutral and calm colour. The exterior material gives a good grip for people with hand disorders.

The parts are attached to each other by gently pushing the case onto the cooling part. The bottom of the case is designed to fit onto the top of the cooler and is somewhat fixed with rubber strip between the parts.

A built-in battery gives the possibility to cool when in between access to power. The solution comes with a power cord and an adapter for charging in cars.

When carrying the full solution, a shoulder strap is attached to both parts. The strap also works as extra support for keeping the parts together.

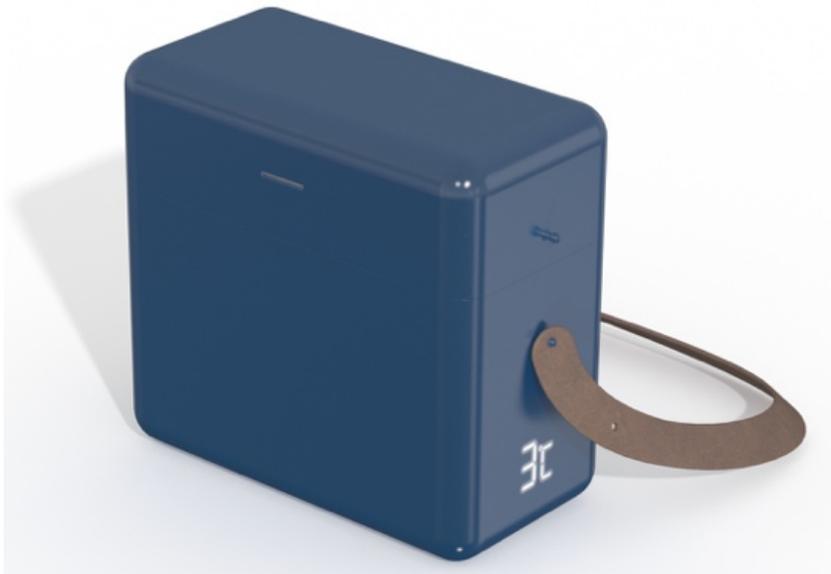
The full concept is about 16 x 17 x 9 cm. The size is an estimation based on benchmarked electronic cooling solutions and the hypothetical dimensions of the reusable auto injector concept.

## 7.3 Prototype

The digital prototype of the storage solution is presented in Figure 7.1-7.5.



**Figure 7.1. The concept placed in a possible environment.**



**Figure 7.2. The full solution ready for transport.**



Figure 7.3. The full solution with the case opened.



Figure 7.4. The case detached from the cooler.



**Figure 7.5. The final concept showing the cooling compartment and the case.**

## 7.4 Evaluation towards the requirements

All of the requirements from the personas are listed in Table 7.1. Julia's are highlighted in blue, Rakel's in green and Mona's in orange. The table shows that most of the requirements are fulfilled.

**Table 7.1 Fulfilment of requirements**

<i>No.</i>	<i>Requirement</i>	<i>Fulfilled?</i>
1	Cooling storage at home	Partially
2	Cooling storage for shorter trips	Yes
3	Cooling storage for longer stays	Partially
4	Easy access to injection device	Yes
5	Easy to open / close	Yes
6	Exterior material with friction for good grip	Yes
7	Aesthetics resembles personal belongings (discreet design)	Yes
8	Allowing for spontaneity	Yes
9	Cooling storage for home	Partially
10	Space for accessories and additional drugs	No
11	Discreet design	Yes
12	Possible to hide at home	Yes
13	Cooling storage for two-week vacation	Yes
14	Possible to bring in personal bag to activities	Yes
15	Cooling function for car trips	Yes
16	Fit pill organizer when travelling	No
17	Aesthetics resembles personal belongings (patterns, exclusive look)	Partially

## 7.5 Reflection

The final concept compromises with some of the personas' requirements, however most of them are fulfilled. Features regarding storing other medications have been out of priority in favour for a smaller size. Bringing other medications has not been considered a huge problem among the users.

The amount of additional drugs vary among the users and most of them have found their own solutions to bring what they need. If for example all users had a pill organizer, the requirement of fitting the item would have been higher prioritized. Even though all the requirements were not fulfilled, the team believes that the solution will be useful for at least some occasions to most users.

## 8 Discussion and conclusion

*This chapter covers a discussion about the thesis project and recommendations for future work. Finally, the conclusions of the thesis are presented.*

### 8.1 The design process

The team is satisfied with the approach of the project and the way it was carried out. Spending more time on meeting users and other stakeholders was both interesting and fun and it generated many useful insights. The interviews did not only reveal findings for this project, but also for future projects within this area. Dealing with the interviews was time consuming and resulted in that other activities had to be reprioritized. This shifted the scope of the project to having a more investigative focus which generated material that can be useful for further development and future projects.

The double diverging-converging phases of the Double Diamond design process helped the team with applying the right mindset through all parts of the process. The project gained from having an iterative approach as it engaged users to contribute to the product development and to influence the result.

The concept generation phase went on smooth since the team felt comfortable with the procedures. Size was an important parameter among most users, and is something that is quite hard to communicate using sketches. Bringing existing products and referring to things that the users were familiar with during the interviews helped the team during evaluations of the concepts.

The team would have liked to include physical prototypes for testing and evaluation with users. The final concept is designed based on the interpreted preferences of the users. New insights could have appeared by letting the

users interact with the concept, unfortunately this was not possible due to time limitations.

## 8.2 Future work

The final concept represents an idea of how a storage solution can function and be designed when having the users in mind. The concept is based on hypothetical dimensions and other assumptions made by the team and things like choice of material, costs, cooling technology and other details have not been considered or specified. This concept idea may work as an inspiration for further development of a storage solution for the reusable auto injector concept.

If continuing the development of the final concept, the following functions and details have to be investigated:

- **Final specifications of the reusable auto injector concept**  
The reusable auto injector concept is under development. Final specifications of the injection device, such as design and dimensions must therefore be determined in order to further develop the storage solution.
- **Cooling system**  
The technology for cooling must be determined. The chosen cooling system must be thoroughly tested to verify that it can keep the temperature within the required range for a certain period of time with a high reliability. The cooling compartment must be equipped with efficiently isolating material and the disposable units must be placed in a way that prevents them from freezing.
- **Temperature feedback**  
The way of giving temperature feedback to users must be investigated. Worries will be reduced by just having a display showing the inside temperature, however, additional features are recommended. Being able to track temperature changes and receiving estimations of the remaining time when running on battery are examples of such features. For this purpose, IoMT could be implemented to facilitate the usage. If having a display, it could be

nice if it was possible to turn it on and off when desired to make the solution more discreet.

- **Usability and ergonomics**

In order for the storage to be user friendly to the target group, usability and ergonomics have to be further considered. A selection of things to consider are:

- A graspable exterior material has to be chosen.
- An ergonomic opening and closing function of the case and the cooling space, as well as attachment of the case from the cooler must be developed and evaluated.
- There should be an ergonomic way of carrying the solution.
- Things concerning the electronic features must be intuitive, for example turning the solution on and off.
- Users with greater physical impact than the interviewees should be able to use the solution in an easy way.

- **Protection**

The storage solution must be designed in a way that protects the drugs and device. A hard case with a tight seal will protect the device from bumps, dust and other surroundings. Both exterior and interior materials should be easy to maintain to keep the injection process hygienic.

- **Costs**

It has to be determined which stakeholder that will carry the costs for the product, and how it should be launched on the market. Depending on the decision, a budget for the project should be established. Cost calculations of different materials, cooling systems and manufacturing methods can thereafter be made in order to establish specifications for the final product.

### 8.3 Conclusion

The research revealed that there are unsatisfied needs among the users of auto injectors. The research also shows that it is possible to create added value through a storage solution, satisfying some of these needs. SHL is recommended to continue investigating in the storage of the reusable auto injector with focus on the users and their lifestyles. A flexible storage solution can strengthen the reusable auto injector concept and make it more competitive on the market.

One finding from the research was that injection treatment is being phased out within MS therapy. It is therefore recommended that SHL investigates in this finding to possibly modify the target group for this, and for other projects.

Although the final concept fulfils most of the user requirements, it is still in an early concept stage and further research and development will be necessary to make it into a product.

# References

## Written and electronic references

- [1] Design Council. (2007). Eleven lessons: managing design in eleven global brands. London, United Kingdom: Design Council. Retrieved September 9, 2018, from <https://www.designcouncil.org.uk/resources/report/11-lessons-managing-design-global-brands>
- [2] Ulrich, K. T. & Eppinger, S. D. (2012). *Product Design and Development* (5<sup>th</sup> ed.). London, United Kingdom: McGraw-Hill.
- [3] IDEO.org. (2015) *The Field Guide to Human-Centered Design* (1<sup>st</sup> ed.). Canada: IDEO.org.
- [4] Norman, D. (2013). *The Design of Everyday Things – Revised and expanded edition*. New York: Basic Books.
- [5] Design Council. (2015). The design process: What is double diamond? Retrieved September 9, 2018, from 2018, from <https://www.designcouncil.org.uk/news-opinion/design-methods-step-3-develop>
- [6] [Hemsida om instruktionsfilmer för rätt användning av läkemedel] (2018, November 3). Retrieved December 2, 2018, from <https://www.medicininstruktioner.se/>
- [7] Medibas. (2013). Autoimmuna sjukdomar. Retrieved August 30, 2018, from <https://medibas.se/handboken/kliniska-kapitel/reumatologi/patientinformation/diverse/autoimmuna-sjukdomar/>
- [8] Tuominen, P. (2017). Multiple Sclerosis - MS. Retrieved September 9, 2018, from <https://www.1177.se/Skane/Fakta-och-rad/Sjukdomar/Multipel-skleros--MS/>
- [9] Piehl, F & Lycke, J. (2014). MS - en översikt. Retrieved September 9, 2018, from <http://www.mssallskapet.se/wp-content/uploads/2018/03/MS-Oversikt.pdf>
- [10] MS guiden. (2018, March 3). Rörlighet och syn. Retrieved September 9, 2018, from <https://www.ms-guiden.se/ms-fakta/symtom-vid-ms/rorlighet-och-syn>
- [11] World Health Organization. (n.d.) Chronic rheumatic conditions. Retrieved September 5, 2018, from <http://www.who.int/chp/topics/rheumatic/en/>
- [12] Martinez, E. (2017) Ledgångsreumatism – RA. Retrieved September 5, 2018, from <https://www.1177.se/Skane/Fakta-och-rad/Sjukdomar/Ledgangsreumatism/>
- [13] Reumatikerförbundet. (2016). Reumatoid artrit (RA). Retrieved September 5, 2018, from <https://www.reumatikerforbundet.org/tag/reumatoid-artrit>
- [14] Reumatikerförbundet. (n.d.) Juvenil idiopatisk artrit (JIA). Retrieved November 10, 2018, from <https://www.reumatikerforbundet.org/tag/juvenil-idiopatisk-artrit>

- [15] Martinez, E. (2016). Barnreumatisk ledsjukdom - JIA. Retrieved November 20, 2018, from <https://www.1177.se/Skane/Fakta-och-rad/Sjukdomar/Ledgangsreumatism-hos-barn/>
- [16] MS International Federation. (2018, July 20). Treatments and therapies. Retrieved September 9, 2018, from <https://www.msif.org/living-with-ms/treatments/>
- [17] Arthritis Foundation. (n.d.). Rheumatoid Arthritis Treatment. Retrieved September 6, 2018, from <https://www.arthritis.org/about-arthritis/types/rheumatoid-arthritis/treatment.php>
- [18] Reuma Shop. (n.d.). Behandling av reumatism. Retrieved October 18, 2018, from [rehttps://www.reumashop.se/sv/behandling-av-reumatism.html](https://www.reumashop.se/sv/behandling-av-reumatism.html)
- [19] Läkemedelsverket. (2015). Biologiska läkemedel. Retrieved September 13, 2018, from <https://lakemedelsverket.se/malgrupp/Foretag/Lakemedel/Biologiska-lakemedel/>
- [20] Psoriasisförbundet. (2017). Biologiska läkemedel. Retrieved September 13, 2018, from <https://www.psoriasisforbundet.se/fakta-o-rad/om-psoriasis/behandling-av-psoriasis/invartes-behandling/biologiska-lakemedel/>
- [21] Arthritis-health. (2017). Risks and Side Effects of Biologics. Retrieved September 6, 2018, from <https://www.arthritis-health.com/treatment/medications/biologics-basic-facts-patients>
- [22] Sandoz. (n.d.). Biologiska läkemedel. Retrieved September 24, 2018, from <https://www.sandoz.se/var-uppgift/biologiska-lakemedel>
- [23] Fass. (2018, October). RoActemra. Retrieved December 10, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20130208000022#side-effects>
- [24] Fass. (2018, October 31). Humira. Retrieved December 10, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20170516000055#side-effects>
- [25] Fass. (2018, August). Avonex. Retrieved September 24, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20110112000110#side-effects>
- [26] Fass. (2018, July). Rebif. Retrieved September 24, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20091210000021#side-effects>
- [27] Lampa, J. (2018, March 2). Reumatoid artrit (RA) och biologiska läkemedel. Retrieved September 24, 2018, from <https://www.internetmedicin.se/page.aspx?id=1349>
- [28] World Health Organisation. (2012). Global Health and Aging. Retrieved September 14, 2018, from [https://www.who.int/ageing/publications/global\\_health.pdf](https://www.who.int/ageing/publications/global_health.pdf)
- [29] McKinsey & Co. (2016). Värdet av digital teknik i den svenska vården. Retrieved September 18, 2018, from <https://www.mckinsey.com/~media/McKinsey/Industries/Healthcare%20Systems%20and%20Services/Our%20Insights/Digitizing%20healthcare%20in%20Sweden/Digitizing-healthcare-in-Sweden.ashx>
- [30] Marr, B. (2018, January 25). Why The Internet Of Medical Things (IoMT) Will Start To Transform Healthcare In 2018. Forbes. Retrieved September 18, 2018, from <https://www.forbes.com/sites/bernardmarr/2018/01/25/why-the-internet-of-medical-things-iomt-will-start-to-transform-healthcare-in-2018/#6f202d8b4a3c>
- [31] Nived, O & Sturfelt, G. (n.d.). Reumatiska sjukdommar. Retrieved November 20, 2018, from

[Shttps://lakemedelsboken.se/kapitel/rorelseapparat/reumatiska\\_sjukdomar.html?search=reumatoid%20&id=p2\\_14#p2\\_14](https://lakemedelsboken.se/kapitel/rorelseapparat/reumatiska_sjukdomar.html?search=reumatoid%20&id=p2_14#p2_14)

- [32] Johannesson, H., Persson, J.-G. & Pettersson, D. (2013). *Produktutveckling - Effektiva metoder för konstruktion och design*. (2<sup>nd</sup> ed.). Stockholm: Liber AB.

## Figures

**Figure 1.1** SHL Group. (2017). SHL Medical Products, Molly®, The Ideal Safety Solution. Retrieved January 14, 2019, from [http://shl.group/Products\\_SHLMedical\\_AutoInjectors\\_Molly.html](http://shl.group/Products_SHLMedical_AutoInjectors_Molly.html)

### Figure 5.1

Preference images:

Backpack: outnorth. Retrieved November 12, 2018 from [https://static.outnorth.com/image/upload/c\\_lpad,d\\_no\\_image\\_chlzht.png,f\\_auto,fl\\_lossy,h\\_1200,q\\_auto,w\\_1200/v1528408931/uploads/live\\_product\\_image/file/0/0/87/87174/fjallraven-kanken-graphite.jpg](https://static.outnorth.com/image/upload/c_lpad,d_no_image_chlzht.png,f_auto,fl_lossy,h_1200,q_auto,w_1200/v1528408931/uploads/live_product_image/file/0/0/87/87174/fjallraven-kanken-graphite.jpg)

Pen case: Åhlens. Retrieved November 12, 2018 from [https://www.ahlens.se/INTERSHOP/static/WFS/Ahlens-AhlensSE-Site/-/Ahlens/sv\\_SE/PDPMegazoom/48APYOSEOM\\_88320220\\_stapel\\_front.jpg](https://www.ahlens.se/INTERSHOP/static/WFS/Ahlens-AhlensSE-Site/-/Ahlens/sv_SE/PDPMegazoom/48APYOSEOM_88320220_stapel_front.jpg)

Portable speaker: CDON.com. Retrieved November 12, 2018 from [https://cdn.cdon.com/media-dynamic/images/product/portablespeakers/portablespeakersdefault/image5/beolit\\_17\\_bluetooth\\_natural-40071086-8.jpg](https://cdn.cdon.com/media-dynamic/images/product/portablespeakers/portablespeakersdefault/image5/beolit_17_bluetooth_natural-40071086-8.jpg)

Pill keychain: shopcdn. Retrieved November 12, 2018 from <https://shopcdn.textalk.se/shop/15251/art51/h1446/122321446-origpic-7cffb7.jpg?max-width=720&max-height=720&quality=92>

Injection device:

Roactemra: Roche. Retrieved November 12, 2018 from <https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQz-ecLwqGOiIcV9-gWjoqf2PNN4Nq3V8zsZ8tofKBOISeGf8JB>

### Figure 5.2

Preference images:

Blue toiletry bag: Multimarket. Retrieved November 12, 2018 from <http://multimarket.se/wp-content/uploads/2017/04/385-1.jpg>

Medical cooler: Nordic Biolabs. Retrieved November 12, 2018 from [http://www.nordicbiolabs.se/MediaBinaryLoader.axd?MediaArchive\\_FileID=f804c6fa-421f-407a-b143-5744d513df20&FileName=B%C3%A4rbar+kyl.jpg](http://www.nordicbiolabs.se/MediaBinaryLoader.axd?MediaArchive_FileID=f804c6fa-421f-407a-b143-5744d513df20&FileName=B%C3%A4rbar+kyl.jpg)

Black toiletry bag: Sportamore. Retrieved November 12, 2018 from [https://cdn-media.sportamore.se/uploads/products/7340076211904\\_001\\_72e9f7d8ab394f0d8120d18124fa37ea.jpg](https://cdn-media.sportamore.se/uploads/products/7340076211904_001_72e9f7d8ab394f0d8120d18124fa37ea.jpg)

Alcoholic wipes: Alibaba. Retrieved November 12, 2018 from [https://guideimg.alibaba.com/images/shop/66/07/31/2/kendall-ap100-alcohol-sterile-prep-wipes-2-ply-medium-100-wipes-per-box\\_1378652.jpeg](https://guideimg.alibaba.com/images/shop/66/07/31/2/kendall-ap100-alcohol-sterile-prep-wipes-2-ply-medium-100-wipes-per-box_1378652.jpeg)

Pills: Turbosquid. Retrieved November 12, 2018 from [http://preview.turbosquid.com/Preview/2015/01/30\\_\\_04\\_37\\_59/signature.jpg83dcaf54-1fa4-4947-a649-2200d07a62c9Original.jpg](http://preview.turbosquid.com/Preview/2015/01/30__04_37_59/signature.jpg83dcaf54-1fa4-4947-a649-2200d07a62c9Original.jpg)

Injection device:

Metoject: MIMS. Retrieved November 12, 2018 from <https://cached.imagescaler.hbpl.co.uk/resize/scaleWidth/620/cached.offlinehbpl.hbpl.co.uk/news/2MM/MetoJect-20140630023356893.jpg>

### **Figure 5.3**

Preference images:

Pill organizer: Medistore. Retrieved November 12, 2018 from [https://www.medistore.se/PICTURE/6527-82-f2000\\_grande.jpg](https://www.medistore.se/PICTURE/6527-82-f2000_grande.jpg)

Optical case: Giga-bikes. Retrieved November 12, 2018 from [https://www.giga-bikes.nl/producten/original/tom\\_brillenetui\\_16x6\\_cm\\_glanzend\\_roze\\_233379.jpg](https://www.giga-bikes.nl/producten/original/tom_brillenetui_16x6_cm_glanzend_roze_233379.jpg)

Phone case: t2day. Retrieved November 12, 2018 from [https://www.t2day.com/ebay/iPhone\\_6\\_Cases/Luxury\\_Genuine\\_Leather\\_Flip\\_Case\\_Wallet/Womens\\_Luxury\\_PU\\_Leather\\_Flip\\_Clutch\\_Zipper\\_Wallet\\_Purse\\_Pouch\\_Case\\_Cover\\_Credit\\_Card\\_Holder\\_Tassel\\_for\\_iPhone\\_6\\_6S\\_Plus\\_Croco\\_Silver\\_05.jpg](https://www.t2day.com/ebay/iPhone_6_Cases/Luxury_Genuine_Leather_Flip_Case_Wallet/Womens_Luxury_PU_Leather_Flip_Clutch_Zipper_Wallet_Purse_Pouch_Case_Cover_Credit_Card_Holder_Tassel_for_iPhone_6_6S_Plus_Croco_Silver_05.jpg)

Black purse: pixabay.com

Injection device:

Rebismart: Basic Home Infusion. Retrieved November 12, 2018 from <https://www.basichomeinfusion.com/blog/Archive/Images/rebismart.jpg>

# Appendix A Work distribution and time plan

*This appendix includes the work distribution during the thesis as well as the initial time plan and the actual outcome.*

## A.1 Work distribution

The project was carried out of the two team members who had similar backgrounds and experiences. Both of them participated in all activities, taking the project forward together. Even though parts of the report have been written individually at first, each part has been thoroughly discussed and reviewed by both. The team members had clearly divided roles during the interviews, where one of them acted as the interviewer and the other one was in charge of observing, recording and taking notes.

## A.2 Project plan and outcome

The project plan was somewhat followed. Most of the planned activities were included in the project, but as the team chose to focus more on investigating in the user needs, some activities were reduced in scope and a few were removed entirely. The user research, and especially the recruitment and execution of interviews, required more time than estimated. The planned Gantt chart shows a more linear process than the actual Gantt chart. Reasons are that the project was well suited for iterative product development and several phases were both iterated and overlapped. The initial and actual time plan is seen in Figure A.1 and Figure A.2.

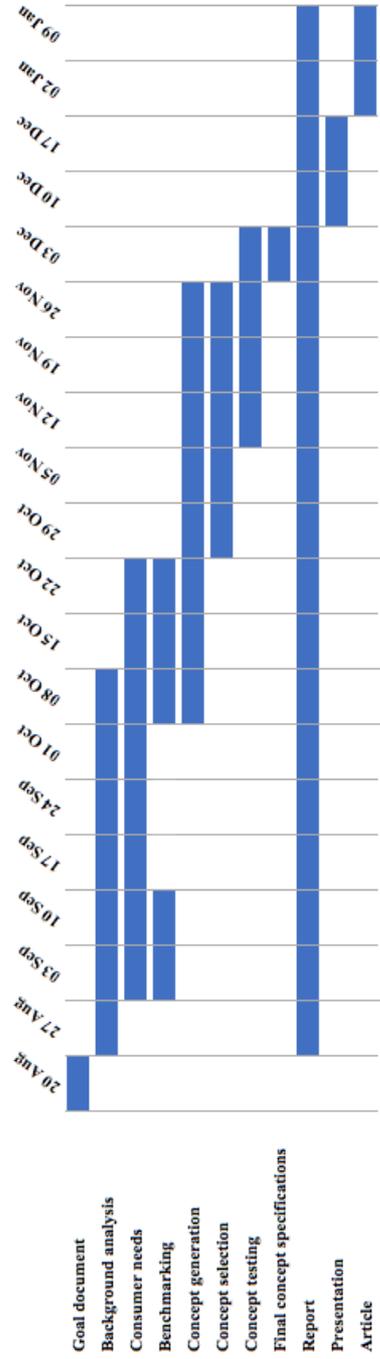


Figure A.1 Initial time plan

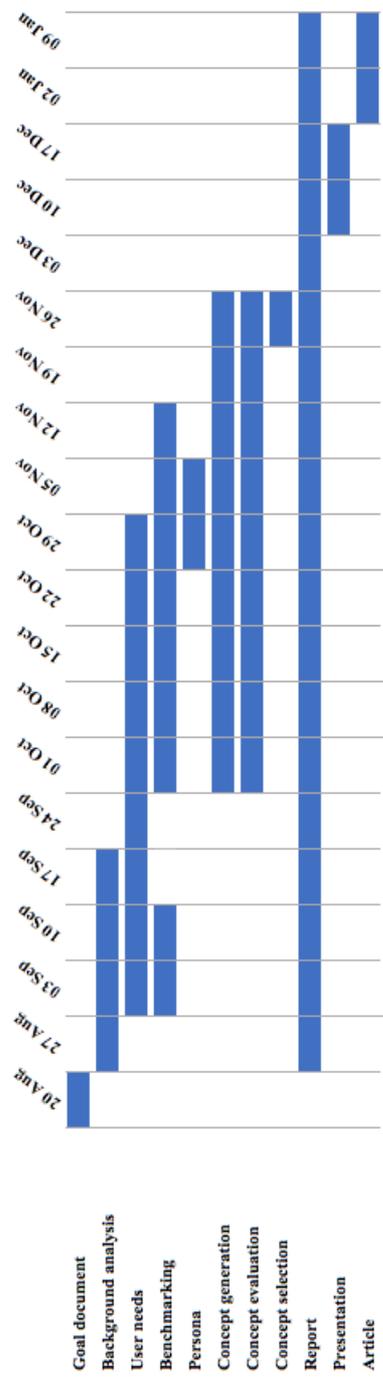


Figure A.2 Actual time plan

## Appendix B Medication research

*This appendix includes tables of handling, usages and package quantities of the biological injectable drugs within the therapy areas.*

### B.1 Handling of and usage of MS drugs

**Table B.1 Storage requirements, injection frequencies and package quantities of drugs for MS.**

<i>Drug</i>	<i>How to store</i>	<i>Injection frequency</i>	<i>Package quantities</i>	<i>Ref.</i>
<b>Avonex®</b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 30°C for max 7 days</li> <li>• Must be protected from light</li> </ul>	1 time / week	4 pcs or 12 pcs (3 packages x 4 pcs)	B.1
<b>Betaferon®</b>	<ul style="list-style-type: none"> <li>• Store in max 25°C</li> <li>• Must not freeze</li> <li>• Must be protected from light</li> </ul>	Every other day	12 pcs (4 packages x 3 pcs)	B.2
<b>Plegridy®</b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 30 days</li> <li>• Must be protected from light</li> </ul>	Every other week	1, 4 or 6 pcs	B.3
<b>Rebif®</b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 14 days</li> <li>• Must be protected from light</li> </ul>	3 times / week	1, 2 or 12 pcs	B.4
<b>Extavia®</b>	<ul style="list-style-type: none"> <li>• Store in max 25°C</li> <li>• Must not freeze</li> </ul>	Every other day	5, 14, 15 pcs or multipacks	B.5
<b>Copaxone®</b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 30 days</li> <li>• Must be protected from light</li> </ul>	1 time / day	7, 28, 30 pcs or multipacks	B.6

## B.2 Handling of and usage of RA and JIA drugs

**Table B.2 Storage requirements, injection frequencies and package quantities of drugs for RA and JIA.**

<i>Drug</i>	<i>How to store</i>	<i>Injection frequency</i>	<i>Package quantities</i>	<i>Ref.</i>
<b>Methotrexate</b>	<ul style="list-style-type: none"> <li>• Store in max 25°C</li> <li>• Must not freeze</li> <li>• Must be protected from light</li> </ul>	1 time / week	1-30 pcs	B.7 B.8
<b>Enbrel<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25° C for max 4 weeks</li> <li>• Must be protected from light</li> </ul>	1-2 times / week	2, 4 or 12 pcs	B.9
<b>Humira<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 14 days</li> <li>• Must be protected from light</li> </ul>	Every other week	1, 2, 4 or 6 pcs	B.1 0
<b>Kineret<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 12 h</li> <li>• Must be protected from light</li> </ul>	1 time / week	1, 7 or 28 pcs (4 packages x 7 pcs)	B.1 1
<b>Cimzia<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Must be protected from light</li> </ul>	Every other – every fourth week	2 pcs or multipacks	B.1 2
<b>Simponi<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Must be protected from light</li> </ul>	1 time / month	1 pcs or 3 (3 packages x 1 pcs)	B.1 3
<b>Orencia<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Must be protected from light</li> </ul>	1 time / week	4 pcs or 12 pcs (3 packages x 4 pcs)	B.1 4
<b>RoActemra<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 30°C for max 8 h</li> <li>• Must be protected from light and moist</li> </ul>	1 time / week	4 pcs or 12 pcs (3 packages x 4 pcs)	B.1 5
<b>Benepali<sup>®</sup></b>	<ul style="list-style-type: none"> <li>• Store in refrigerator 2-8°C</li> <li>• Must not freeze</li> <li>• Can be stored in max 25°C for max 4 weeks</li> <li>• Must be protected from light</li> </ul>	1 time / week	4 pcs or 12 pcs (3 packages x 4 pcs)	B.1 6

## Appendix B References

- [B.1] Fass. (2018, August). Avonex. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20110112000110>
- [B.2] Fass. (2018, June). Betaferon. Retrieved September 25, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=19951130000010#usage-and-administration>
- [B.3] Fass. (2018, October). Plegridy. Retrieved December 10, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20130718000048>
- [B.4] Fass. (2018, July). Rebif. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20091210000045>
- [B.5] Fass. (2018, June 14). Extavia. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20071106000045>
- [B.6] Fass. (2018, October 5). Copaxone. Retrieved December 10, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20040312000057>
- [B.7] Fass. (2018, August 14). Ebetrex. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20071201000025>
- [B.8] Fass. (2018, October 12). Metojectpen. Retrieved December 10, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20120503000148>
- [B.9] Fass. (2018, July). Enbrel. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20090731000022>
- [B.10] Fass. (2018, October 31). Humira. Retrieved December 10, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20150901000020>
- [B.11] Fass. (2018, April 6). Kineret. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?nplId=20121129000048>
- [B.12] Fass. (2018, July 19). Cimzia. Retrieved September 25, 2018, from <http://www.fass.se/LIF/product?userType=2&nplId=20160323000010>
- [B.13] Fass. (2018, September). Simponi. Retrieved September 25, 2018, from <https://www.fass.se/LIF/product?nplId=20080305000046>
- [B.14] Fass. (2017, July). Orencia. Retrieved September 25, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20150131000029>
- [B.15] Fass. (2018, October 29). RoActemra. Retrieved December 10, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20180328000020>
- [B.16] Fass. (2018, October 2). Benepali. Retrieved December 10, 2018, from <https://www.fass.se/LIF/product?userType=2&nplId=20141220000020>

# Appendix C Benchmark

*This appendix includes the benchmark of existing reusable injectors and their storage solutions.*

The internet searched benchmark is found in Table C.1. Other storage solutions were benchmarked from interviews with users and from SHL.

**Table C.1 Benchmark of existing reusable injectors.**

<i>Name</i>	<i>Image</i>	<i>Reference</i>
<b>Surepal™</b>		C.1
<b>Precision pen injector®</b>		C.2 C.3
<b>Betaconnect™</b>		C.4
<b>Elcam reusable auto injectors</b>		C.5 C.6
<b>Rebismart™</b>		C.7

## Appendix C References

- [C.1] Surepal (n.d.). How to use Surepal. Retrieved September 14, 2018, from <https://www.surepal.com/how-to-use-surepaltm>
- [C.2] SHL Group. (2018). Case Study PPI. Retrieved September 14, 2018, from <http://www.shl-group.com/downloads/case-study-shl-medical-PPI-auto-injector-2018.pdf>
- [C.3] SHL Group. (2017). PPI. Retrieved December 10, 2018, from [http://shl.group/Products\\_SHLMedical\\_AutoInjectors\\_PPI.html](http://shl.group/Products_SHLMedical_AutoInjectors_PPI.html)
- [C.4] FCC ID.io. (2013). BETACONNECT – Instructions for use. Retrieved September 14, 2018, from <https://fccid.io/2AAGY-BETAC1/User-Manual/15-betaCONNECT-UserMan-2128729>
- [C.5] E3D Elcam Drug Delivery Devices. (2016). Flexi-Q eMU-P. Retrieved September 15, 2018, from <https://www.elcam3d.com/product-flexi-q-emu>
- [C.6] E3D Elcam Drug Delivery Devices. (2017). Flexi-Q eMU-P by E3D Elcam Drug Delivery Devices. [Video file]. Retrieved September 15, 2018, from <https://www.youtube.com/watch?v=RrOaho7J5xc&t=125s>
- [C.7] Merck. (n.d.). Dosing and Administration. Retrieved November 25, 2018, from <https://www.merckneurology.com/en/rebif/getting-started/dosing-and-administration.html>
- [C.8] BasicHomeInFusion. (2017). Smart Usage Among Young, Less Disabled MS Patients May Improve with More Knowledge. Retrieved December 10, 2018, from <https://www.basichomeinfusion.com/blog/Archive/Rebismart-Usage-RRMS-Patients.html>

# Appendix D Interviews

*This appendix includes the summaries from the interviews held during the user research.*

## D.1 Summaries of interviews with HCP

### D.1.1 Interview with N1

N1 works as a children's rheumatology nurse at Karolinska Institutet and has been working there for ten years. Her patients are between 0-18 years and she has a lot of experience of onboarding families and teenagers when starting an injection treatment. According to her it is more common to treat children with injections rather than with tablets. One reason is that it can be difficult for children to swallow tablets every day or multiple times a week. Where she works, the nurses participate when deciding which treatment a patient should be prescribed. She experiences that there is a demand for reusable auto injectors.

N1 thinks that a storage solution should be easy to use. It is important that the treatment is smooth and can be adapted to the user's lifestyles, especially when it comes to teenagers since they are more likely to skip the treatment it is troublesome. All parts should be easily accessed and taking them out should not require force since many of the patient have pain in fingers and wrists. She thinks that the design shouldn't stand out, instead it should have a discrete and neutral look. She believes gender neutral colours like grey and black would be a good idea since the subject can be a sensitive topic among youths.

Cooling bags are often used and always handed out with drugs that requires to be stored cold. She mentions that the nurses make sure that the families are provided with information about the cooling requirements and the cooling bags. A cooling bag must be reliable since the patients should be able

to trust that the medications are stored in the right temperature. She has had experiences with gel packs as they get dry and have to be replaced.

The nurses try to guide families in how to think regarding the treatment in order to make it as natural as possible in their everyday lives, and N1 points out that it is important to try to live a normal life. They discuss how to think about storage and security checks when travelling, and sometimes suggests patients to inject in advance when going away for a short period of time to facilitate the trip.

She ends with lifting that she thinks this research is interesting and important since many patients bring up questions regarding these issues. Many patients feel limited by the disease and the treatment and the day of injection often controls their lives.

#### **D.1.2 Interview with N2**

N2 started working as a MS nurse in 1999 and is currently working at the Center of neurology at Karolinska Institutet. She has experiences from the boom of injectors within MS therapy. Treatment with tablets and infusion is getting more common at the reception at Karolinska while treatment with injectors is being phased out among the newly diagnosed. One reason is that patients experience that injecting is troublesome and that they get a lot of side effects. She also mentioned that the injection drugs have a limited effect on the disease.

At the beginning, there was a huge issue with the cold storage requirements of the drugs. Later, it became possible to store the prescribed drugs in room temperature for a week which facilitated for the patients. She does not recall that there were any problems with storing the drugs in the refrigerator at home but as soon as it came to travelling the patients thought it was quite a hassle. There were a lot to think about, how to get through customs, bringing a cooling bag with ice packs and making sure that the room temperature at the destination did not exceed 25°C. She recalls a patient calling from a vacation in Thailand panicking about the AC not working and the temperature being above 30°C. However, the ones struggling the most were the people frequently travelling for business who had to inject every other day. They had problems with planning their trips and remembering to bring and take their medications.

The patients often take additional drugs. Medications that are commonly combined with the injection drug are pain relievers, antidepressants, antiepileptics for neurogenic pain and antispasticity drugs.

She remembers that most of the injectors came with a case or a cooling bag. Some of the drugs came with a whole backpack including a cooling bag, ice packs, a case, a notebook and a pen. These kits were appreciated, however most patients only used some of the gadgets. The storages came in various designs and materials. Since the storages came with the prescribed drug there were no possibilities for the patients to choose. Most of them seemed to be satisfied with the given storage.

N2 thinks that it is important for a storage not to be too big but in the same time it needs to have details large enough to be graspable for patients with fine motor and sensory problems. She emphasizes the importance of a neutral design without large logos. People want to be able to be discrete with their medications.

### **D.1.3 Interview with N3, N4**

N3 and N4 work as MS-nurses at the University Hospital in Lund. They have worked there for 20 and 35 years and have experience from the changes that came with the biological drugs. According to them, in 1985 there were no treatments for MS patients, and it changed very quickly when the biological drugs became available. Rebif and Avonex were among the early treatment drugs.

N3 and N4 says that it is more common with tablet and infusion treatments than injection. One reason is that a lot of patients dislikes injecting.

The nurses are involved in the prescription phase. They always show the patients what alternatives of drugs and devices there are. Some patients ask for drugs that they are familiar with and that have been on the market for a while.

During the interview, the nurses demonstrated and showed devices, starter kits and cooling bags for different drugs. They also demonstrated how to inject with RebiSmart and Copaxone. RebiSmart is delivered with a hard case holding the electronic device and needles. The team together with the nurses evaluated the case which for example has a sliding mechanism for

opening the case, and agreed on that it was very hard to understand and to open.

The nurses also showed a starter kit that came with RebiSmart. It was a black backpack that contained the case with the device, a cooling bag with three ice packs, a cooling gel that can be applied on the injection site after the injection and a toolkit to use when changing batteries in the device.

## D.2 Summary of interviews with pharmacies

All pharmacies experience that a lot of patients collecting their medications have few questions about the drugs and the injection process. Nurses and doctors have already provided the necessary information.

Most patients collect drugs for three months at a time, which is a maximum to collect since these drugs are covered by the high-cost protection. Since the drugs are sensitive and expensive the pharmacies do not have a lot in stock. Their customers are recommended to order prior to picking up to make sure that they have their drugs in store.

The visited pharmacies do not give out any storage solutions for the medications and none of the pharmacies have cooling bags in their assortment. The pharmacist at Apotek Hjärtat remembers that one drug used to be delivered with a case but she does not recall the design of it. She says that there is a demand for storage solutions and that customers have asked for it. At Apoteksgruppen in Varberg they receive a lot of questions on how to travel with the drugs, they say that there are many elderly who wants to go on longer vacations. The pharmacy refers to the healthcare to provide the patients with the correct information on how to travel with the drugs.

The employees at Apoteksgruppen explained that the pharmacies hand out sharps bins in smaller sizes. They also have special plastic bags for disposed injectors/syringes. Some patients bring their own bags which is not allowed. The pharmacist must be able to see that there are no visible needles before they can collect the waste.

## D.3 Summaries of interviews with users

### D.3.1 Interview with U1

Age: 60

Sex: Female

Diagnose: Rheumatoid Arthritis, RA

Occupation: Disability pension

U1 lives in a house in the south-western part of Sweden. She has a dog and a horse that she visits and takes care of on days when she feels good. She enjoys outdoor activities, animals and the nature and she has been practicing skiing during her whole life. U1 has a summer house in Dalarna that she goes to every now and then. Her parents live close by and she visits them two times per day. Her 20 year old daughter lives in another city.

She says that she has had a rough life with many misfortunes. Despite that she describes herself as positive and down-to-earth and states that she is nowadays very satisfied with her life.

She is an educated anthropologist but due to lack of jobs she has worked as a youth recreation leader. She has also studied to become a secretary with two languages. During her working life she has been burnt out and been on sick leave. She has been on work practice with Arbetsförmedlingen several times but nowadays she does not work anymore. To her, continuity leads to anxiety and social phobia.

U1 got her diagnose in 2008, a few years after her symptoms occurred. The doctors did not take her seriously at first. Her first prescribed drug was Methotrexate and she describes it like she got her life back at that point. As a side effect she received many prolonged infections and she became forgetful and started acting strangely. Her symptoms are pain and stiffness, mainly in hands, arms and knees.

She dislikes meeting people on the street without making an appointment. The main reason is that she does not have the energy to take care of her appearance. Due to this she often takes the car somewhere when she has to walk her dog. She is very tired all the time and she only does the essential things to get through the day.

U1 switched to injecting Enbrel around 2012. She sometimes receives auto injectors but prefers syringes as the auto injector hurts more. The drugs are stored in her refrigerator at home. She is supposed to inject once a week but due to the many infections she only injects every other week. She usually feels more or less okay for one and a half week after an injection but the last days prior to the next one are often horrible. When it is time for an injection she takes it straight from the refrigerator without waiting because she thinks that it hurts less when the drug is cold. She injects in the kitchen, standing up when using a syringe and sitting down when using an auto injector. Usually she injects in the afternoon or in the evening. It is not unusual that she postpones her injection one or a few days.

In addition to her biological drug she takes Naproxen and Ipren, and sometimes when she cannot take Enbrel due to illnesses, she gets a cortisone cure. She stores her other medications in a kitchen cabinet.

When picking up the drugs at the pharmacy, she prefers to pick up a large amount so that she does not have to do it very often, hence reducing the risk of meeting someone that she knows. However, it is rarely possible since the pharmacies does not have a lot of these drugs in storage. She lives close to the pharmacy, therefore she does not bring any cooling bag when picking up the drugs. When she was prescribed Enbrel she received a cooling bag but she had to buy the ice packs herself.

When going to her summer house, she does not bring her medications. In fact, she has never travelled with the drugs and she says that she does not go abroad any longer. U1 wishes that there was a safe way to bring the drugs but she does not trust the cooling bag, mainly because she thinks that the drugs might freeze in it. When receiving the cooling bag she got instructions on how to use it but she has never been told how many ice packs she should use with it. She experiences that the cooling bag is mainly for transport of the drugs from the pharmacy to the home.

U1 would like to live a more free life and wants to be able to go abroad for a month at the time. One dream that she has is to travel around the world by train. She would like to be more free in relation to her drugs since freedom is related to wellbeing. In order for her to do this, she needs a cooling solution for her drugs that lets her know what temperature they are stored in and for how long they will remain cold. She suggests using the power outlets in the

trains or in a car to cool the drugs with electricity. The amount of drugs that she would like to bring is four to eight syringes. She does not care about the aesthetics at all but would prefer something like a shoulder bag or a backpack.

### **D.3.2 Interview with U2**

Age: 34

Sex: Female

Diagnose: Multiple Sclerosis, MS

Occupation: On sick leave

U2 lives with her son and husband in an apartment in Stockholm. She enjoys reading, painting and crafting although most of her time is spent on taking care of her two-year-old son.

Her friends and family started commenting on her balance which turned out to be symptoms of relapsing remitting MS. She got the diagnose in 2009 and one year later, in 2010, the doctors found a brain tumour which was later removed. At first she had a very negative attitude towards her disease but as the years have passed she feels that she has become a friend with it. In her everyday life, she mainly struggles with lifting heavy things and has problems with balance and night vision. Despite that, she doesn't feel very limited by the disease.

Prior to the pregnancy, she was treated with Avonex through injection with prefilled syringes once a week. She describes the feeling she had during the onboarding with her doctor and nurse as a great sorrow and recalls that she had a lot of anxiety during that time. After her son was born she started with Plegridy disposable auto injectors which she injects two times per month. She experiences the treatment with auto injector as more pleasant than with prefilled syringes, however she dislikes the sound of the injector being activated and she questions the fact that the disposables are very large and made out of a lot of plastics.

The walk to the closest pharmacies takes five to ten minutes and she collects medication for three months at the time, which in her case is three packs, each one containing two injectors. When she gets home she unpacks the injection devices from the original packaging and puts them in a large

lunch box made of glass on a shelf in the refrigerator. She also collects prescribed alcoholic wipes from the pharmacy.

She injects in the kitchen every other Friday at 4 pm. To remember the injections she writes a note in her calendar. She used to have an app called Florence for reminders but stopped using it because she thought it was complicated to use it. After the injection she disposes the injection device in an old gingerbread jar that she stores in the kitchen cabinet above the stove. The size of the injection devices makes them impossible to fit into the sharps bin that she was given by the pharmacy, therefore she had to use something else.

U2 always takes painkillers after the injections. She also takes vitamins every morning. These pills, together with the rest of the family's medications are stored in a kitchen cabinet next to the refrigerator. It's important to her that the drugs and the disposed devices are stored out of reach from her son.

She prefers to keep all her medications in the same place. If she would have had a reusable auto injector she would like to store it together with the other drugs. She would like a simple and nice-looking storage that is easy to open, yet child proof, possibly with a key or a code lock. The design of it should blend in with other things in her home and it should not have a "*hospital-like look*" nor a logo of a pharmaceutical company. She would appreciate a case where everything has its own place; the reusable injection device, the pills and the alcohol wipes. Another idea would be to have an external refrigerator where she could fit all of the medications mentioned above, as well as injection drugs for three months of treatment. If she had such a solution she would still place it in the kitchen, somewhere out of reach from her son.

### **D.3.3 Interview with U3**

Age: 60

Sex: Female

Diagnose: Multiple Sclerosis, MS

Occupation: Disability pension

U3 lives with her husband in a house on the west coast of Sweden. Earlier she lived in Gothenburg and has been working at restaurants during her

whole life. Today she is on disability pension and enjoys taking walks. U3 is very open about her disease and has participated in studies and lectures about MS. She is very satisfied with the healthcare and the HCP that she has been in contact with since she got her diagnose. Even though she now lives an hour from Gothenburg, she still goes there to see her doctor.

U3 was diagnosed with relapsing-remitting MS in 2007. It started in 2000 with vision problems. Since her mother has MS, the diagnosis didn't come as such a chock. Her treatment started with Avonex injections once a week. She experienced that Avonex was hard to inject, and she had a lot of side effects. Due to the side effects, she later switched to Copaxone, which she injected every day. After problems with the lymph node she started taking Gilenya tablets and has now been eating one every morning for the last two years.

Her disease impact is mostly difficulties with her balance, impaired vision, losing words while talking and sometimes forgetting things. In addition to her biological drug she takes anti-inflammatory medications, drugs for restless legs and for urinary problems. She uses a pill organizer in which she places pills for two weeks at a time. The pill organizer is stored in her bedside table together with her other drug packages.

When she was on Avonex she had a reusable auto injector that came in a dark blue, softcase. In the case there was a cooling pillow that could be applied on the injection site prior to injection. She liked the case and used it to store the injection device. The case with the device was stored in her bedside table and the drugs were stored in the refrigerator. Copaxone came in disposable syringes that she kept in the refrigerator. She experienced that they were easier to use compared to the Avonex device.

She used to take her injections in the evening. Whenever she would be away for a dinner or a celebration, for example on new year's eve, she had to excuse herself and leave the table to inject. This is something she thought was annoying to plan for and to do.

When collecting her drugs from the pharmacy she picks up drugs for three months at a time. Since she's always been living close to a pharmacy she never brought a cooling bag when picking up the biological injection drugs. When going on vacation she has used a cooling bag and remembers that it

was hard to plan the trip due to her treatment. Today they no longer go on vacation, and when she thinks about it, it might be because of her disease.

U3 prefers a storage solution that is discrete and fits with her other belongings, things that “look nice” and sometimes a bit exclusive. It doesn’t have to “look so boring” and “it shouldn’t be showing that you are sick”. She would like it to be small and fit in her personal bag or hand luggage. It could look something like an “evening purse” that is suitable to bring to dinners.

#### **D.3.4 Interview with U4**

Age: 40

Sex: Female

Diagnose: Rheumatoid arthritis, RA

Occupation: Entrepreneur

U4 lives with her husband and two children in the southwest of Sweden. She works at her own company and enjoys going horseback riding and taking care of her garden. Even though she works a lot she has always stayed active and worked out. Every week she used to hold a workout class at a gym in her town. U4 describes herself as an independent and thoughtful person that does not hesitate to help others.

She was diagnosed with RA at the end of the summer in 2018 after having pain in hands and feet. Three years earlier she was tested for RA with a negative result after having pneumonia. She experiences that she has felt sick ever since, thinking it could be RA. After getting the diagnosis she was worried about the future and how the disease will affect her everyday life. The disease has stopped her from holding her workout class and going horseback riding and she is now thinking about new workout forms that are gentler to the body. She hopes that she will be able to return to her interests in the future.

She has started her treatment with eight methotrexate tablets once a week combined with cortisone, vitamins and anti-inflammatory tablets every day. In the near future she will also start with a biological drug. When discussing the biological treatment, she and her HCP first talked about infusing a drug. Since she’s not afraid of syringes she asked for injections instead. When starting with injections she will probably inject in the bedroom or in the bathroom after a shower.

She collects methotrexate for three months at a time, which is about 100 tablets. The tablet drugs and her other medications are stored in a kitchen cabinet. She prefers to store her medications separate from “the common family medications”. Even though she would rather not use a pill organizer, “that makes her feel old”, she might consider it with all the tablets she is currently taking.

The family usually goes to vacations one week at a time. For her toiletries and makeup, she uses a bag that hangs and has compartments for toothbrush, deodorant and sunscreen. She prefers “something black with patterns” and “something cool” for the design of a storage solution. She wants it to be possible to have it visible in her house. If she was to use a pill organizer she wants it to be less “sickness-like”.

#### **D.3.5 Interview with U5**

Age: 39

Sex: Female

Diagnose: Rheumatoid arthritis, RA

Occupation: Economist

This summary has been left out to protect the anonymity of the interviewee.

#### **D.3.6 Interview with U6**

Age: 26

Sex: Female

Diagnose: Juvenile idiopathic arthritis, JIA

Occupation: Engineer

U6 lives in the middle of Sweden with her boyfriend and she works as a Design Engineer. In her spare time she enjoys hanging out with friends, going out for beer, watching TV-series, drawing and reading books even though she feels like she does not have enough time for reading. She also likes to have mini projects running, building things or fixing up stuff. Two years ago, she bought an old bicycle that she rebuilt.

When U6 was 1,5 years old she was diagnosed with JIA. Her parents discovered that she had problems with her knees, that they were swollen. After the discovery, she was quickly diagnosed with JIA and started with treatment right away. Since the diagnose, she thinks she has had problems with all of her joints in the body. Mostly she has had issues with her feet, knees and her wrists. Her problems are relapsing and now it has been years since she had a greater relapse. During the last ten years it has been more of “the regular pain”, the everyday things such as stiffness in the morning. These problems also come and go in lighter relapses and is affected by how much she exercises, if she is overworking and how well she adheres to her medications. Even though she has not experienced a greater relapse for a while, she still has unexpected problems sometimes. Last summer she woke up with swollen knees, this was something she did not think she deserved since she could not recall she had done anything different. She has not had any major problems with her hands, especially not her left hand which is the one she uses when injecting. Today she injects in her stomach which is no problem. When she was younger, her parents injected in her legs, which she later experienced was a hard angle for her. Her grip is good but she misses support for her arm when she holds the injection device against the injection site.

Her treatment today consists of painkillers every morning and when necessary during the day, one cortisone tablet every morning and D-vitamins. Once a week, she injects RoActemra with a prefilled syringe. Her treatment started with methotrexate tablets. Since pre-school she has injected medications, mostly methotrexate, and also methotrexate in combination with other biological drugs. Today she only injects RoActemra which she feels is good since methotrexate made her feel nauseous.

She injects in the evening in the kitchen. She usually takes the drug out of the refrigerator, where she stores them, before dinner, and injects after dinner. She has no problems with injecting, she has gotten used to it, however, she says that if she would not have been diagnosed with the disease, she would probably be scared of needles. When she was younger, her parents injected on her, it took some time before she dared to inject on herself. Her parents taught her how to inject, it started with them inserting the needle and then letting her inject the medication. She recalls that she easily got a bump beneath the skin by the methotrexate syringes, something she does not get with RoActemra.

She stores her other medications in a box made of sheet metal that she has on her kitchen table. All the medications do not fit in the box, some are standing around it on the table. In the box, she also keeps alcoholic wipes that she uses prior to injection. These are not included with the drug, but it has been included with all her previous injection devices. U6 collects two packages of RoActemra at a time, each package contains four syringes each. When transporting them home from the pharmacy she does not use a cooling bag since she lives so close to the pharmacy.

Remembering to take the injection has become harder for U6. She says that it has been easy to remember when injecting once a week. Now she has been using RoActemra for four to five years and the effect of it has deteriorated lately. Therefore, her doctor recommended her to start taking it every 6th day. Even though she sets an alarm, it is hard to remember. If she forgets to inject and takes the drug one day later, she adjusts the alarm.

It has been a while since she last travelled with her injection drug. Her doctor has told her that it is troublesome to bring the drugs, and that changing the injection day to one day earlier or one day later does not matter if she's going away for the weekend or for a week. She has flown with drugs that requires cold storage before, she then used a cooling bag with ice packs and she had to bring a drug certificate, which worked good. For one trip the stewardess took care of her medications during the flight and also helped her to re-freeze the ice packs. With one drug she received a small cooling bag that they later used for picnics with the family.

When she lived with her parents, and in her first apartment, she had a medicine cabinet in the kitchen that she really enjoyed, it was easily accessed. In her second apartment, there was also a medicine cabinet, but high up in a closet, which was hard to reach for her. That was when she bought the box that she uses today. Her injection drugs are usually stored all the way back in the refrigerator in their original package and with food in front of them. Prior to every injection, she has to move everything in front of the drugs to reach them. She prefers storing her medications in the kitchen and if she would use a reusable injector, she would probably store it in the kitchen, in the box with her other medications.

Since the needle is hidden after injection, she collects her disposed syringes in a plastic bag and returned to the pharmacy. The plastic bag is also stored in the kitchen.

For a storage solution she prefers a box similar to the one she uses today, but with a cooling compartment for her injection drugs. All the medications in the same place is something she would appreciate. According to U6, a storage solution should be discreet, non-medical looking and it should look like something that fits in a kitchen. She has no problem with having a storage solution visible or in a cabinet. She likes the idea of a storage solution that is portable and that is not cooled with ice packs, it would be smoother, as long as it is not too big.

### **D.3.7 Interview with U7**

Age: 24

Sex: Female

Diagnose: Unknown rheumatic disease

Occupation: Student

U7 moved from Skåne, where she grew up, to Stockholm a few months ago. She lives in a big apartment with two other women at her age. She likes cooking, yoga, spending time with friends and shopping. When she gets home from her studies she usually goes to the gym to work out, makes dinner and watches series. U7 enjoys travelling. During the last years, she has spent one year as an exchange student in USA, from where she did several trips within the area, she has been travelling to Morocco with her family and she recently went backpacking in Asia for a few months.

Pain in the joints, mainly in the wrists and fingers, appeared suddenly during the summer after she graduated from high school. She got an unknown rheumatic diagnose one year later, when she was 19. She experiences temporary severe pain and is currently in a period with a lot of pain. She has had problems when studying for exams since it involves a lot of handwriting and when working out, she usually can't use dumbbells as an example.

Her treatment began with Methotrexate tablets which she took for six months. She then switched to Metoject due to nausea, and injected the drug for another six months. She stopped since she still experienced a lot of nausea as a side effect. U7 recently started with another, milder medicine in tablet form after a few years without any regular treatment. During all types of treatment, she has been taking anti-inflammatory pills, usually one every

morning and an additional pill when needed. Now she also takes cortisone tablets, and pills for the stomach.

She feels that her disease is not limiting her that much in her everyday life, even though she experiences a lot of pain from time to time. What she worries about more is how the symptoms will develop over time, since she is still young.

When U7 had Metoject as her treatment she lived with her parents and her sister. She injected in the kitchen every morning during breakfast and had no problem with remembering it. The disposable injection pens were stored in one of the vegetable boxes in the refrigerator and they were disposed in a sharps bin that was placed under the sink. She recalls that the sharps bin was small, it could only fit a few injection pens. They received another sharps bin but they still had to return the waste quite often. Her parents helped her with picking up the drugs at the pharmacy close by once a week.

Since she only had the injection drugs for half a year she didn't experience going abroad with them, however she recalls bringing them in an ordinary cooling bag when going to their summerhouse at Öland since the outside temperature could exceed 25°C.

Today she stores her medications together with other toiletries in the bathroom. She also keeps one blister pack of each medicine in a box next to the bed, and it's from those packs she takes her pills in the morning. She expresses that she would like to store all her pills in the same place, preferably in some kind of case. However, she states that "pill organizers are only for 90 year olds".

When talking about a potential reusable injection device she mentions a case that her cousin who has diabetes is carrying his/her injection pen in. She would like a hard case to feel safe since the drugs comes in glass containers. If her medications would require to be stored in the refrigerator she would have liked to store the reusable device someplace close to the refrigerator. Now that she lives with others she would prefer to store all her medications in her bedroom, close to other things that she uses every day, like her handbag for example.

She prefers a neutral look for a storage, it could for example look like a pencil case in a dark colour. She thinks that it would be nice to have a custom fit

cooling case for the medications rather than getting a normal cooling bag, and for travelling she would like to gather both the device, the injection drugs, other medicines and alcoholic wipes. She thinks that the optimal amount of doses to bring is four or five. U7 thinks that a cooling solution would be very useful when travelling but she would not like to have a separate cooler when she is at home since it would take up too much space, therefore she suggests something modular. Other things that she points out as important is that a case should be easy to grip and hold as well as open and close. The opening device should be large enough to grip with the whole hand rather than with two fingers. A case should allow for being opened in a 180° angle so that everything is perspicuous and reachable. Several times she states that the storage should be as small as possible as well as lightweight in relation to its functions.

#### **D.3.8 Interview with U8**

Age: 26

Sex: Male

Diagnose: Rheumatoid arthritis, RA

Occupation: Engineer

U8 works as a consultant and lives in the south of Sweden in a two-room apartment. He enjoys playing golf, working out and going out with friends. Next year he will participate in the ski competition Vasaloppet. U8 describes himself as healthy. He is reminded of his disease when he experiences pain, mostly in fingers, knees and hips. When playing golf, he uses a different grip to release some pain from his pinky finger. Walking longer distances can be tough, therefore he mostly gets around on his bicycle.

U8 was diagnosed with RA at the age of 15. It started half a year earlier with problems in his shoulder, problems with sleep and had a hard time to dress himself. Later he had a throat infection and inflammations in joints that led to the discovery of RA. In the beginning he was very tired and slept a lot. His treatment started early after diagnosis with methotrexate tablets every day combined with cortisone, vitamins and tablets for stomach. After a while he switched to Metoject, injected two times a week. With methotrexate he was pain free for about four years. When the symptoms started to come back he switched to Enbrel, injected once a week. After four years, he switched again to RoActemra which he is currently taking. He had a hard time switching

between the biological drugs and had to walk with crutches in the last transition period.

He injects every Sunday evening and always in his legs. He keeps the pre-filled syringes in their original package in the refrigerator and prior to injection he takes one out and place it on the kitchen table to let it heat to room temperature. The injection process takes place either at the kitchen table, or on the couch. When he collects the drugs at the pharmacy he usually collects for three months at a time and transport them home in his personal bag. Sometimes he runs other errands before returning home with the packages to put them in the refrigerator. He disposes the syringes in the trash since they have a needle cover.

Travelling is a part of U8's life. He has been backpacking in Asia, lived in France and he often travels by train in Sweden to visit his parents, friends and for work. While travelling in Asia he ate methotrexate tablets. He has received a cooling bag with ice packs from the nurses that he has been using when he travels by plane and when he drove down to France. Even though he was sometimes worried about the temperature, he experienced that it was easy to travel with the syringes.

U8 would prefer to store a reusable auto injector in the refrigerator with his injection drugs. In that case, he will know where to find it. Black colour, non-medical looking and portability are his preferences about a storage solution. He is positive to a smaller electronic cooler that contains medications for one or two weeks to use when he goes away for the weekend and shorter trips. It is important that it fits in his weekend bag. The storage solution should be as small as possible and he would rather have his other medications elsewhere if that can minimize the size. When going away for longer trips with more luggage "it will not be the same project to pack" and would rather use a cooling bag. Storing his medications at home is not a problem for U8, his other medications he keeps in a bathroom cabinet.

### **D.3.9 Interview with U9**

Age: 23

Sex: Female

Diagnose: Juvenile idiopathic arthritis, JIA

Occupation: Student

U9 currently lives in Colombia as an exchange student for six months. She lives with four other students in an apartment. She loves to travel and this is her seventh time of being an exchange student. She has also been working as a tour guide in several countries. During her childhood she played a lot of basketball and she likes sailing. In her spare time she enjoys spending time with friends, going to cafés and working out at the gym.

She got her diagnose when she was one and a half years. Her state of illness has been going up and down during her whole life and she has tried several drugs. Some periods have consisted of frequent hospital visits. She has problems with 15 joints. During the first year of high school she had a surgery of her wrist and two years later doctors surgically fixated one of her ankles. Nowadays the main problems are in her knees. She has weak hands and problems when using too much force with her thumbs.

Her treatment consists of Metoject and Simponi whereas the latter has been alternated with Enbrel for the last five or six years. She injects Metoject once a week and Simponi once a month, both using an auto injector device. When she was little she always injected while sitting down in the sofa in the family's living room since she was afraid of needles. Now she injects anywhere close to a trash bin since she throws everything in there, usually in the kitchen. She uses paper, alcoholic gel and wet wipes when injecting. Other medications that she takes are tablets against nausea five times a week, eye drops and Naproxen when needed.

Even though U9 is used to travelling with her drugs, she thinks is really troublesome to do it. Simponi is very temperature sensitive which makes it complicated. When travelling with by air she is usually not allowed to store the drugs in the airplane refrigerator. She has not received any cooling bags with her drugs but she has found a cooling bag that she is satisfied with on the internet, called iCool Prestige. It uses gel packs that are placed in compartments. The problem with this kind of solution is, according to U9, the lack of control regarding the temperature. When travelling for a longer time she has no idea of whether the drugs are okay or not. During these six months in Colombia she just has to hope that the drugs have not been destroyed on the way there. When travelling with her drugs, she removes the packaging to save up some space.

U9 would prefer an electronic, reliable cooling solution before a cooling bag even though it would have been clumsier. Since people are not very careful

when handling bags at for example the airport and in the airplane, she prefers a hard case solution. She would like a solution that also works for storing the drugs at home, especially now that she lives with four other students. Since the tap water is undrinkable in Colombia, her flatmates boil water and put it in the refrigerator while it is still hot. This is threatening to her drugs and she therefore stores them in another refrigerator that belongs to the landlord.

### **D.3.10 Interview with U10**

Age: 25

Sex: Female

Diagnose: Juvenile idiopathic arthritis, JIA

Occupation: Student + working extra

U10 lives with her dog and a friend in an apartment in Stockholm. She studies to become a programmer and is working extra at a tech company. She loves nature and spends much of her spare time out in the woods and in her family's cabin in Åre. She goes out for long walks with her dog every morning and evening and she works out or does yoga every day. She says that her life consists mainly of computers and forest.

She was diagnosed with JIA at an age of two and has had problems with her whole body, from the jaw down to the toes. She recalls that the disease did not affect her everyday life very much when she was younger but says that it has gotten harder to get the life puzzle to work without any aid now that she is an adult.

When U10 was 17 years she participated in a test group for Enbrel. Nowadays she is on Benepali that she injects once a week. She has had a lot of problems with handling her needle phobia. Earlier she used prefilled syringes and now after attending cognitive behavioural therapy she can use injection pens. She has always used an anesthetic cream on the injection site prior to injection but this is something that she is trying to phase out from the injection process. She always injects every Tuesday evening after taking a long and hot shower. She locks herself in in the bathroom not to be frightened by something when injecting. She then applies the cream and sits on the toilet lid for half an hour waiting for it to kick in. She feels that this procedure is troublesome, yet necessary.

She often collects drugs for three months of use at the time. The drugs can be stored in room temperature for one month. She puts drugs for two months in the refrigerator and store the rest in a box next to her bed together with her other medications. The requirements for cooling storage have varied during her treatment and she admits that she is a bit unsure of what the requirements are right now. Apart from the injection drugs she takes medications for her eyes and her stomach every day, and painkillers when needed.

Her state of health varies from day to day. The disease makes her tired and forgetful and she sometimes forgets an injection. She has tried several apps for keeping track of the treatment but nothing has worked in the long run.

U10 usually goes abroad for a maximum of three weeks each time, often to some place warm. She skips bringing her injection drugs so that she doesn't have to keep track of the temperatures. When travelling in Sweden she brings a cooling bag during the summer. Ever since she was a teenager she has been dreaming of travelling for a longer period, for example backpacking in Asia like most of her friends did after finishing high school. She has felt limited to doing that because of the requirements of the drugs.

She uses disposable injectors and has earlier thrown the waste in the trash. She knows that it is possible to leave the units at pharmacies so she recently started collecting the injectors in a plastic bag. She thinks a lot about the environment and would appreciate a reusable device to reduce the amount of plastic that is being disposed.

U10 wants to own as few things as possible and she wants them to be minimalistic and discreet. She would like a storage that makes it easy to travel with the drugs and she would appreciate if she could put the injector storage in her own bag. She is quite picky with what her things looks like and would not like to use a backpack from a pharmaceutical company as an example. She once received a cooling bag without any ice packs when she was prescribed a new drug. She would like something that is adapted to suit the drugs so that it is reliable. A storage should be discreet and have a neutral look with dark colours.

### **D.3.11 Interview with U11**

Age: 50

Sex: Female

Diagnose: Multiple Sclerosis, MS

Occupation: Shop assistant, blogger, entrepreneur

U11 lives with her husband and three children in Stockholm. She works part time as a shop assistant at a retail store and has a blog where she writes about MS. She enjoys working out at the gym and do yoga. Together with her kids, she makes and sells bracelets where the revenues are donated in favour for MS. She is very engaged around MS and has held lectures about her disease journey for others with the same diagnosis. She is very open minded and wants to do something important by contributing to others with the same disease with her experiences.

In late 2010, she was diagnosed with relapsing-remitting MS. It started with changes in sensations and she experienced tingling and numbness in her feet and legs. After seeking care, the doctor did not suspect MS since her sister has the diagnose and it is very rare for two siblings to both have MS. Instead she was prescribed chiropractic which made it worse. The numbness crawled up to her chest and her skin was burning. She ended up in the hospital and was then diagnosed with MS. For almost a year she was put in a wheelchair paralyzed from her bust and down. It was a tough period and she felt that her identity was gone and had to always depend on help. Her treatment started with Rebif, injected three times a week and rehabilitation to train her to walk again. The Rebif made her feel sick and she had new relapses. They switched to Tysabri, infused every fourth week, which she is currently on.

The Rebif was injected with a reusable electronic injection device, Rebismart, that she injected around 6 pm every other day. She usually injected in the kitchen after dinner, and cannot recall that it was hard to remember to take the injection. Rebismart came in a hard case. Since Rebismart has a weekly dose per ampule she had to switch needles after every injection. The needles were stored in a kitchen cabinet and the medications together with the case containing Rebismart was stored in the refrigerator. At the pharmacy, she collected medications for three months at a time. After injecting she had fever chills and got red marks on the injection site on her stomach. The side effects disturbed her everyday activities and she had to pass on dinners on injection days.

When switching from Rebif her only alternative was to take Tysabri infusions. At first she felt sick again when having to go back to the hospital for the infusion every month. After a while she appreciated the visits since it

was a chance to talk to nurses about her disease and symptoms. She feels that the hospital is an access to have a dialogue and keep track of the development of her disease.

Prior to injections she always had to painkillers. Other medications and wipes she stored together with the needles in a plastic box in the kitchen cabinet. Wherever she goes she always brings a makeup bag with drugs she takes when necessary.

At the beginning of her disease she did not dare to travel. She was scared that something would happen to her and that she would not get the healthcare she needed. 2011 the family went to Turkey and after an otitis she ended up in the hospital. Ever since she is worried about abroad vacations even though she does not want the disease to stop her from travelling. Since then the family has been on vacations in USA and Spain and every summer they go to their summer house in Dalarna. The healthcare won't let her take her infusions in another county and she had to travel back and forth to Stockholm during the summer to receive her treatment. This makes her feel that she is dependent on "her hospital".

Her daughter was diagnosed with Diabetic type 1 and it is important to her that she shows her daughter that it is possible to travel with a disease. Even though U10 does not travel with medications that requires cooling anymore, her daughter does. She feels that there is no need for a portable refrigerator since she always calls hotels prior to reservations to make sure they have a refrigerator on the room.

She would prefer to store her medications in something "simple and black that does not show that you are sick". Earlier, while on Rebif, she searched for a bag that had room for both the Rebismart case, painkillers and the drug certificate that is a must to bring when travelling by plane. She would like it to be "like a pen case" or "a travel kit". Comparing to diabetes, she feels that are so much more products and options to store insulin than for MS. When diagnosed with diabetes there are a lot of start kits available, this is something she thinks should be available for people diagnosed with MS as well.

# Appendix E Interview guides

*This appendix includes the interview guides that were used for conducting the interviews.*

## E.1 Interview guide for interviews with nurses

- Berätta lite om ditt yrke, hur länge du jobbat med det här..
- Berätta om hur det går till när en person har blivit förskriven biologiska läkemedel
  - Vad får de för info gällande behandling, uthämtning, förvaring
  - Hur är pat. attityd gällande injektor? begränsningar, möjligheter..
  - Vad har de för frågor, orosmoment
- Hur vanligt förekommande är det med återanvändbara injektorer?
  - Hur ser ni på de förvaringslösningar som medföljer?
  - Har ni någon erfarenhet eller rutin på var pat. förvarar sin biologiska medicin och sin övriga medicin?
  - Vad tror ni är viktigt med en förvaring?
    - vad ser ni kan förbättras med de befintliga?
    - vad är viktigt att tänka på?

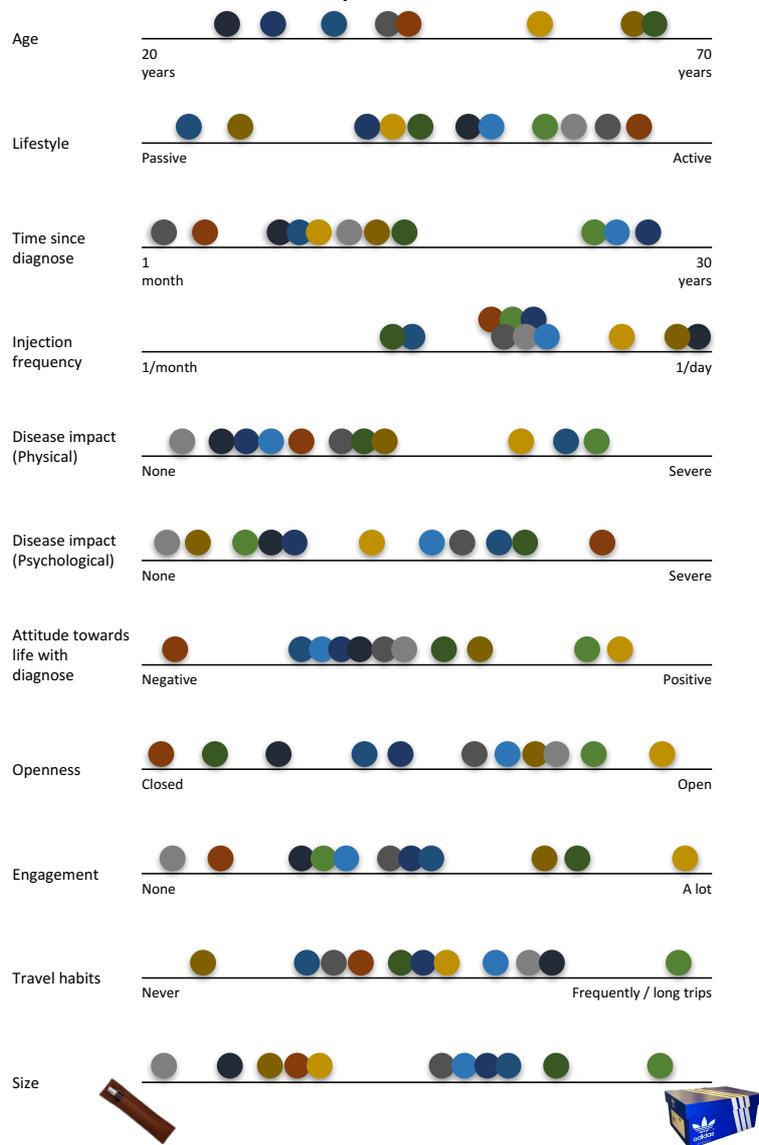
## E.2 Interview guide for interviews with users

Område	Guide till intervju/användarstudie
Personligt/ livstil	<ul style="list-style-type: none"> <li>• Berätta lite om dig själv</li> <li>• Vad är din sysselsättning?</li> <li>• Beskriv dina fritidsintressen</li> <li>• Hur ser din vardag ut? Vad gör du en typisk veckodag?</li> <li>• Vad brukar du göra på helgerna?</li> </ul>
Hälsa	<ul style="list-style-type: none"> <li>• Berätta lite om din sjukdom och när du blev sjuk</li> <li>• Hur ser du på din sjukdom? Attityd</li> <li>• Hur har din attityd förändrats från sjukdomsdebut-nu?</li> <li>• Hur ser din behandling ut?</li> <li>• Har behandlingen förändrats över tiden?</li> <li>• Har du andra sjukdomar, hjälpmedel, mediciner?</li> <li>• Hur har din livsstil förändrats sedan du blev sjuk?</li> </ul>
Auto- injektor	<ul style="list-style-type: none"> <li>• Hur länge har du injicerat?</li> <li>• Vilket läkemedel tar du just nu?</li> <li>• Hur upplevde du introduktionen till behandlingen?</li> <li>• När och var tar du den?</li> <li>• Hur mår du efter en injektion?</li> <li>• Hur får du hem medicinen? Flödet, Hur många? Vad kommer dom i för förpackning</li> <li>• Demonstrera: Var förvaras medicinen? Hur går medicineringen till, var slängs den efter injektionen? (Process)</li> <li>• Hur upplever du injiceringen med AI? Problem?</li> <li>• Hur har du koll på att du har injicerat och när du ska injicera?</li> <li>• Nämn alla saker du använder i samband med injektionsprocessen från innan till klart</li> </ul>

Övrigt	<ul style="list-style-type: none"> <li>• Hur gör du när du reser/ åker bort? Planering? Vad måste du ha med dig?</li> <li>• Kan du beskriva en resa du gjort med mediciner?</li> <li>• Vad begränsar dig?</li> <li>• Var förvarar du dina andra mediciner?</li> <li>• Om du skulle ha en återanvändbar autoinjektor, var skulle du förvarat den så du kommer ihåg var du lagt den?</li> </ul>
Förvaring	<ul style="list-style-type: none"> <li>• Presentera att vi tittar på hur en återanvändbar AI kan förvaras</li> <li>• Hur skulle du vilja förvara?</li> <li>• Finns det saker du använder i anslutning till injektion?</li> <li>• Vad tycker du är viktigt med en förvaring? Preferenser?</li> <li>• Färgpreferenser</li> <li>• Vilka viktiga funktioner bör en förvaring ha?</li> </ul>

# Appendix F Scales of characteristics

*This appendix includes the table of scales used for clustering the characteristics to create the personas.*



# Appendix G Benchmark

*This appendix includes the benchmark of medical cooling solutions.*

**Table G.1 Benchmarked medical cooling solutions.**

<i>Name</i>	<i>Image</i>	<i>Reference</i>
Portable cold box		G.1
Diabetic cooler bag		G.2
Anaphylaxis emergency response case		G.3
iCool Prestige		G.4

**iCool Medicube**



G.5

**Travelsafe Iso medi bag**



G.6

**Frio insulin cooling cases**



G.7

**Diabetes cooler box**



G.8

**26L Portable mini refrigerator**



G.9

## Appendix G References

- [G.1] Ec21. (2018). Portable Cold Box. Retrieved November 3, 2018, from <https://www.ec21.com/product-details/Mini-Medical-Fridge-Battery-Powered--9817098.html>
- [G.2] Walmart. (n.d.). Diabetic cooler bag. Retrieved November 3, 2018, from <https://www.walmart.com/ip/Diabetic-Cooler-Bag-Oxford-Fabric-Medical-Travel-Cooler-Bag-Insulin-Cooling-Case-For-Diabetics-Medication-Cool/324838908>
- [G.3] Allergy Lifestyle. (2018). EpiPen Bag. Retrieved November 3, 2018, from <https://www.allergylifestyle.com/shop/allergy-shop/epipen-cases/anaphylaxis-emergency-response-case/>
- [G.4] Medactiv. (2017). iCool Prestige. Retrieved December 10, 2018, from [https://medactiv.com/en/transport-of-medication/37-icool-prestige.html?search\\_query=prestige&results=2](https://medactiv.com/en/transport-of-medication/37-icool-prestige.html?search_query=prestige&results=2)
- [G.5] Medactiv. (2017). iCool Medicube. Retrieved November 16, 2018, from <https://medactiv.com/en/transport-of-medication/38->
- [G.6] vidaXL. (2018). Travelsafe Iso Medi Bag. Retrieved November 16, 2018, from [https://www.vidaxl.se/e/8712318067690/travelsafe-iso-medi-bag-medicinsk-kylvaska-ts52?utm\\_source=vidaxl\\_shopalike&utm\\_medium=price\\_comparison&utm\\_campaign=se\\_webshop&utm\\_term=8712318067690&utm\\_content=Sportartiklar](https://www.vidaxl.se/e/8712318067690/travelsafe-iso-medi-bag-medicinsk-kylvaska-ts52?utm_source=vidaxl_shopalike&utm_medium=price_comparison&utm_campaign=se_webshop&utm_term=8712318067690&utm_content=Sportartiklar)
- [G.7] Frio. (2013). FRIO Insulin Cooling Cases. Retrieved November 25, 2018, from <https://www.frioinsulincoolingcase.com/>
- [G.8] Made-in-china.com. (n.d.). Joyikey Battery Powered Small Cases/Diabetes Cooler Box /Insulin Cooler Box/Insulin Pen Cases. Retrieved December 10, 2018, from [https://www.made-in-china.com/showroom/joyikey/product-detailAXIxmisTRfRD/China-Joyikey-Battery-Powered-Small-Cases-Diabetes-Cooler-Box-Insulin-Cooler-Box-Insulin-Pen-Cases-Keeping-in-2-8-Degrees-with-Ce-Approved-.htmlY7S5AON0mlDg8Rs3BePkaAiwzEALw\\_wcB](https://www.made-in-china.com/showroom/joyikey/product-detailAXIxmisTRfRD/China-Joyikey-Battery-Powered-Small-Cases-Diabetes-Cooler-Box-Insulin-Cooler-Box-Insulin-Pen-Cases-Keeping-in-2-8-Degrees-with-Ce-Approved-.htmlY7S5AON0mlDg8Rs3BePkaAiwzEALw_wcB)
- [G.9] Alibaba. (2018). Portable Mini Refrigerator. Retrieved November 25, 2018, from [https://www.alibaba.com/product-detail/26L-Portable-Mini-Refrigerator-Mini-Fridge\\_60786238158.html?spm=a2700.7724857.normalList.31.6f167c55Iz6LtW](https://www.alibaba.com/product-detail/26L-Portable-Mini-Refrigerator-Mini-Fridge_60786238158.html?spm=a2700.7724857.normalList.31.6f167c55Iz6LtW)

# Appendix H Concept scoring matrix

*This appendix includes the concept scoring matrixes used for evaluating the concepts towards the requirements.*

## H.1 Julia

**Table H.1 Concept scoring matrix of Julia's requirements**

<i>Requirement</i>	<i>A</i>			<i>B</i>			<i>C</i>			<i>D</i>		
	<i>Weight</i>	<i>Points</i>	<i>Weighted points</i>									
Cooling storage at home	0.2	4	0.8	0	0	4	0.8	0	0			
Cooling storage for shorter trips	0.2	2	0.4	4	0.8	5	1.0	0	0			
Cooling storage for longer stays	0.2	4	0.8	2	0.4	4	0.8	0	0			
Easy access to injection device	0.1	5	0.5	3	0.3	5	0.5	5	0.5			
Easy to open / close	0.1	5	0.5	4	0.4	5	0.5	5	0.5			
Exterior material with friction for good grip	-	-	-	-	-	-	-	-	-			
Aesthetics resembles personal belongings (discreet design)	-	-	-	-	-	-	-	-	-			
Allow for spontaneity	0.2	2	0.8	3	0.6	5	1.0	3	0.6			
<b>Total</b>	<b>1.0</b>	<b>22</b>	<b>3.8</b>	<b>16</b>	<b>2.5</b>	<b>28</b>	<b>4.6</b>	<b>13</b>	<b>1.6</b>			

## H.2 Raket

**Table H.2 Concept scoring matrix of Raket's requirements**

<i>Requirement</i>	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>		
	<i>Weight</i>	<i>Points</i>	<i>Weighted points</i>						
Cooling storage at home	0.3	5	1.5	0	0	4	1.2	0	0
Space for accessories and additional drugs	0.2	5	1	3	0.6	0	0	1	0.2
Discreet design	-	-	-	-	-	-	-	-	-
Possible to hide at home	0.3	3	0.9	5	1.5	4	1.2	5	1.5
Cooling storage for two-week vacation	0.2	3	0.6	3	0.6	5	1.0	0	0
<b>Total</b>	<b>1.0</b>	<b>16</b>	<b>3.7</b>	<b>11</b>	<b>2.7</b>	<b>13</b>	<b>3.4</b>	<b>6</b>	<b>1.7</b>

## H.3 Mona

**Table H.3 Concept scoring matrix of Mona's requirements**

<i>Requirement</i>	<i>A</i>		<i>B</i>		<i>C</i>		<i>D</i>		
	<i>Weight</i>	<i>Points</i>	<i>Weighted points</i>						
Possible to bring in personal bag to activities	0.6	0	0	3	1.8	0	0	5	3.0
Cooling function for car trips to Österlen	0.3	4	1.2	5	1.5	5	1.5	0	0
Fit pill organizer when travelling	0.1	5	1.0	5	0.5	0	0	0	0
Aesthetics resembles personal belongings (patterns, exclusive look)	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1.0</b>	<b>9</b>	<b>2.2</b>	<b>13</b>	<b>3.8</b>	<b>5</b>	<b>1.5</b>	<b>5</b>	<b>3.0</b>

