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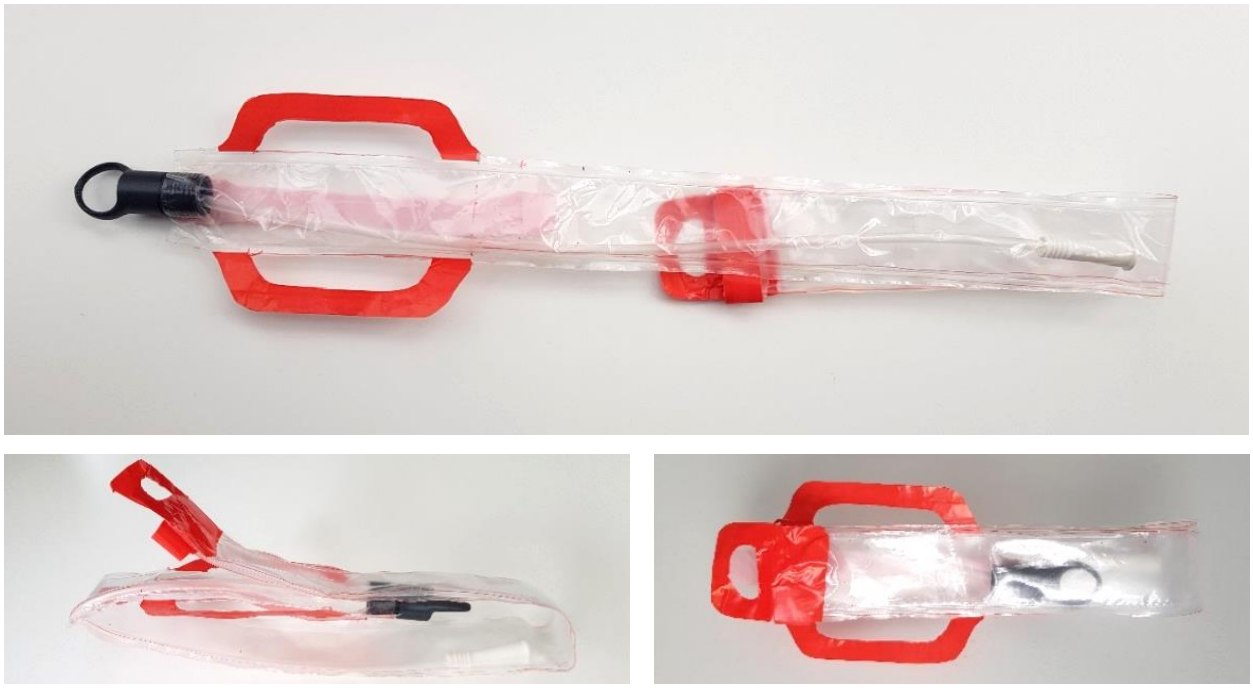

Using Design to Facilitate Self-Catheterisation for Tetraplegics with Low Hand Function

Proposing a Product Concept and Design Guidelines when Designing for People with Lower Tetraplegia

Master's thesis in Industrial Design Engineering

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2024
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Image of a prototype of the final suggested conceptual product design, Estela M. Ankarbåge

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Abstract

The master thesis project “Using Design to Facilitate Self-catheterisation for Tetraplegics with Low Hand Function. Proposing a Product Concept and Design Guidelines when Designing for People with Lower Tetraplegia”, by Estela Marie Ankarbåge, was carried out at the department of Industrial Design Engineering at Chalmers University of Technology. The project has been performed in collaboration with Wellspect HealthCare situated in Mölndal, Sweden.

People with a high spinal cord injury, also called tetraplegics, are encouraged to manage activities of daily life independently to increase their self-esteem and self-confidence. Wellspect HealthCare noticed them struggling to empty their bladder by intermittent catheterisation. Although many are capable to perform the catheterisation independently, they may still need assistance to manage the various catheter products. The aim of this study was to investigate the user experience of intermittent self-catheterisation among tetraplegics with low hand function and explore if and how a product could be designed to facilitate the self-catheterisation procedure. We investigated what barriers prohibited the users from experiencing an easy intermittent catheterisation and how a product could be designed to facilitate intermittent catheterisation and increase tetraplegics’ independence.

This was a qualitative study looking to discover and understand attitudes, experiences, and emotions connected to self-catheterisation. Six users, three healthcare professionals, and Wellspect employees partook in interviews, a focus group, and a workshop. The data was organised into general themes and looked at from a product pleasure perspective that provided a holistic understanding of the user experience.

It was found that people with lower tetraplegia struggle with catheter products not catering to their low hand function, which makes their self-catheterisation experience filled with negative emotions. Emotions such as worry, shame, and disgust emerged before, during, and after catheterising. Users and experts alike found today’s procedure unoptimized for tetraplegics, where several product interactions required a higher hand function.

Based on these insights, a conceptual product design was created to remove an important barrier to an easier self-catheterisation: attaching an extension tube to the catheter. The concept was later evaluated by a urologist who compared today’s user experience with their perspective of the user experience with the concept. Additionally, design guidelines were formulated to aid in future product development projects for tetraplegics with low hand function.

Key words: *User experience, Intermittent Self-Catheterisation, Tetraplegia, Low Hand Function, Catheter, Extension Tube, Assistive Devices, Product Pleasure, Product Development, Wellspect*

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Wellspect Healthcare AB, my biggest thanks to offering such an interesting and important topic for this master thesis project. It has acted as an eye opener to understand how big of an impact a MedTech-product, such as the intermittent catheter, can make in people's lives. I am grateful to Hanna Molinder and Martin Lovmar, my Wellspect supervisors, who provided both their knowledge and patience as they guided me through this challenging study.

I would like to express my deepest appreciation to Siw Eriksson, my supervisor at Chalmers, who consistently helped me gain clarity by challenging my thoughts and guided me with valuable life experiences.

I am also grateful to my pragmatic examiner Bijan Aryana, director of the MSc Industrial Design Program, for being accommodating to this study's uncertainties and obstacles, and able to adjust his hectic schedule to examine this study.

Lastly, I haven't forgotten the countless evenings where I was stuck in front of the computer while my dear Benny took care of the baby, cooked, cleaned, and made sure the bills were paid. Thank you, Benny, for always supporting me.

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1 Introduction

Today in Sweden, 6000 people live with a spinal cord injury (SCI) and around 300 people sustain an SCI each year (Hultling, 2017). A person can either have a slow onset SCI where a condition worsens over time, or a person can have an acute SCI where an injury occurs suddenly either from outside trauma, e.g. a car accident or stroke. Those who get an SCI are left with either limited to no motor and sensory functions, and dysfunctional organ systems. Such a severe injury will impact all "activities of daily life" (ADL) and require a long adjustment time to relearn how to manage ADL with a new body. Compared to the rest of the population, life quality is lower among people with an SCI (Jörgensen, 2017). Efforts are put in to support them managing ADL independently to adequately increase their self-esteem and self-confidence which may encourage them to take on new challenges throughout life and improve life satisfaction (Sjöberg, 2020). An SCI almost always causes the urinary system to malfunction and consequently affects life quality negatively (Andersson, 2018).

Clean intermittent catheterisation is the desired method to drain the bladder from urine, although other methods might be more appropriate depending on the individual's prerequisites. Yet compared to other methods, intermittent catheterisation lowers the risk for bacterial growth and therefore lessens the risk for urinary tract infections (UTIs). It also lowers the risk for stone formation and bladder cancer (urothelial carcinoma) (Jörgensen, 2017). Intermittent catheterisation can be performed on oneself or with assistance. A fair number of tetraplegics with low manual dexterity must revert to other methods because they cannot successfully self-catheterise. With an increasing proportion of incomplete SCIs, thanks to improved safety equipment and emergency care at accident sites and hospitals, more people can urinate by themselves (Hultling, 2017; Holtz & Levi, 2010), yet it is still required to catheterise and remove residual urine to avoid UTIs. Depending on the injury's completion level and residual hand function, it is possible to self-catheterise (Ryggmärgsskada.se, n.d.; Kriz & Relichova, 2014) which is strongly encouraged by both healthcare and legislation (United Nations [UN], n.d.; Sveriges Riksdag, 2022).

1.1 Commissioning Company

Wellspect HealthCare (Wellspect) is a global company and an industry leader in continence care with their headquarters in Mölndal, Sweden. They offer products for bladder and bowel care under the brands LoFric® and Navina™ as well as information for patients and healthcare professionals (HCP). Wellspect is the first company to offer a urinary catheter with a unique hydrophilic coating which creates a super slippery surface. Currently, the urinary product offering caters to people with medium to high manual dexterity. Wellspect has noticed tetraplegics with low manual dexterity having difficulties self-catheterising and therefore initiated this master thesis project to discover how to improve their experience.

The results will act as a stepping stone to further Wellspect's understanding of the user group and provide a conceptual product design which may facilitate the intermittent self-catheterisation procedure.

1.2 Aim and Objectives of Study

The aim is to investigate the user experience of intermittent self-catheterisation among tetraplegics with low hand function and explore if and how a product can be designed to facilitate the self-catheterisation procedure.

The objectives are to understand the users' needs and prerequisites and embody these learnings in a product design concept.

1.3 Research Questions

RQ 1: What barriers prohibit the users experiencing an easy intermittent catheterisation?

RQ 2: How can a product be designed to facilitate intermittent catheterisation and increase independence?

1.4 Report Outline

The structure of the report (fig. 1) starts with *Introduction* and *Background* to provide the context in which the study is conducted. The main part of the study is separated into two phases. The theme of *Phase One* is understanding the users through qualitative research.

The findings lead to identifying different user groups, a couple UX goals, and an indication of how the desired self-catheterisation process could look like. These insights act as a foundation for creating concepts and making design choices in *Phase Two*. *Phase Two* shows the progression of the concept development process and ends with a section about design guidelines for future product development projects for tetraplegics with low hand function. Lastly, the paper ends with a discussion and conclusion.

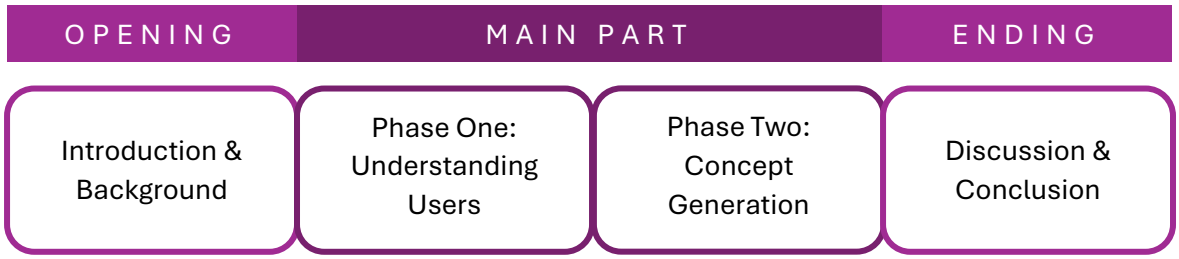


Figure 1. The structure of the report.

2 Background

This chapter introduces the condition tetraplegia, how it affects dexterity, and which hand grips are possible to use. Further on, it presents the procedure intermittent self-catheterisation and complications, how and where the users learn to self-catheterise, catheter products, and commonly used assistive devices. The study takes on a holistic design approach by using Jordan's (2000) four pleasure framework.

2.1 The Condition Tetraplegia

Tetraplegia is when the spinal cord injury occurs between vertebrae C1 and T1 which affects all four limbs (National Institute of Neurological Disorders and Stroke [NIH], 2022); around 50% of SCI patients have tetraplegia (Holtz & Levi, 2010). People with high tetraplegia (C1-C4) require respiratory aid and help with all personal hygiene. Lower tetraplegia (C5-T1) however, allows a higher degree of independence because of a higher residual function in the arms (see fig. 2).

2.1.1 Tetraplegic Hand Grips

Lower tetraplegia C5-T1 affects finger coordination, dexterity, and grip strength. To compensate for the function loss and inability to manipulate objects, the user needs to find ways to stabilize and provide leverage when handling an object. For some users there is a possibility to undergo surgery to improve the overall hand function.

Mulcahey (1994) and Ford and Duckworth (1987) identified six hand grips used by tetraplegics to compensate for their loss of strength and dexterity (see fig. 3). However,

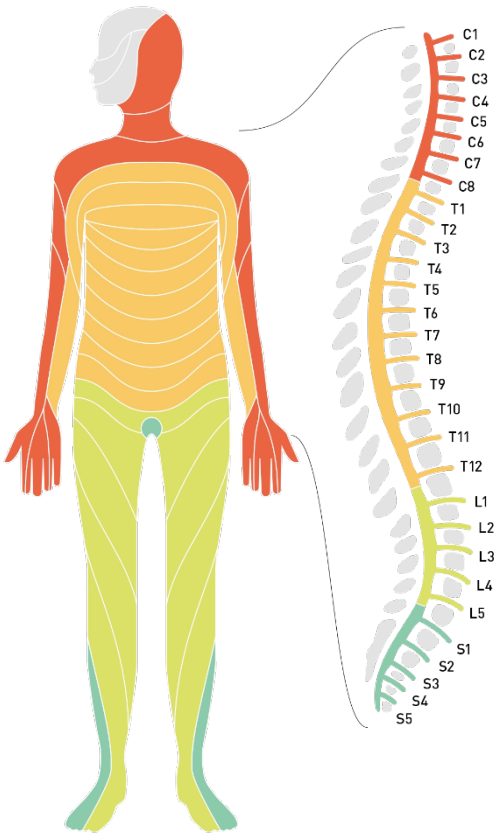


Figure 2. The Spinalis Foundation's illustration of which vertebrae affect different parts of the body. Lower tetraplegia affects vertebrae C5-T1. Retrieved from: www.ryggmärgsskada.se

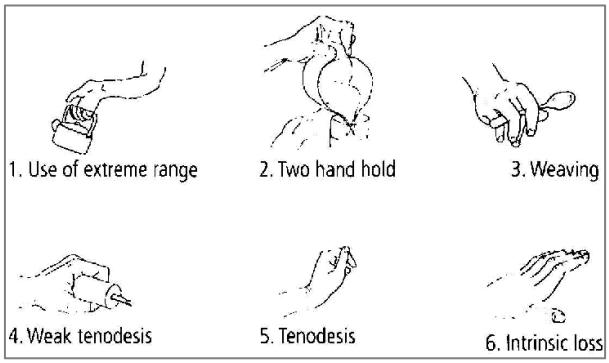


Figure 3. Hand grips to compensate for loss of strength and dexterity. Image source: Curtin, M. (1999). An analysis of tetraplegic hand grips. British Journal of Occupational Therapy, 62(10), 444-450.

users tend to switch quickly between grips as they handle an object.

Curtin (1999) analysed patients with complete SCIs at level C6-C8 and according to him, these patients need to use pre-grip preparation (see fig. 4) to securely grasp an object. The most common types of pre-grip preparations were: stabilise with non-dominant hand while grasping with the dominant hand, drag object to the edge of the table with the dominant hand, and use both hands to pick up object.

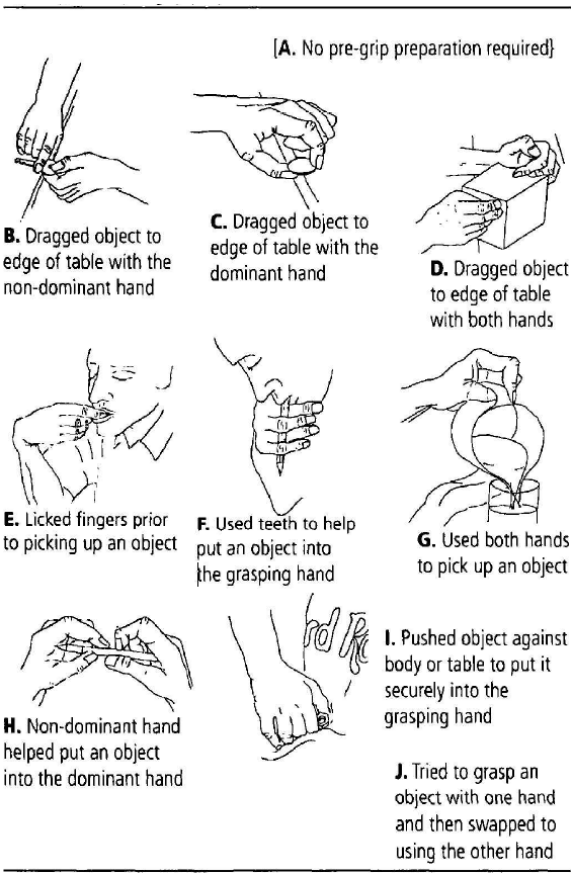


Figure 4. Pre-grip preparations. Image source: Curtin, M. (1999). An analysis of tetraplegic hand grips. British Journal of Occupational Therapy, 62(10), 444-450.

2.2 The Intermittent Catheterisation Process

The process intermittent catheterisation is about using a catheter to empty the bladder regularly throughout the day. A user usually empties their bladder 4-6 times per day. To minimize autonomic dysreflexia symptoms and the risk of UTIs, the user shouldn't wait any longer than four hours between catheterisations and/or let the amount of urine in the bladder exceed 400 ml (Giannantoni, 1998; Thulin & Strålöga, 2022). Users can intermittently catheterise in different locations. It could be while sitting on the toilet, in a wheelchair, or lying down on a bed.

To insert the catheter into urethra, the user holds the catheter by the connector (see fig. 4) and aims the catheter directly into the urethral opening. The user continues to push the catheter until urine starts coming out, then the user waits until it stops flowing and pulls out the catheter 1-2 cm to see if there is any residual urine left. Once there is no urine left, the user pulls out the catheter and disposes it in the trash can. Best practice is to put the catheter back into the package and fold it before putting it in the trash can. Some catheters can be cleaned and reused.

This method has become the golden standard within healthcare as the risk of urinary tract infections (UTIs), stone formation, and bladder cancer is lower compared to other catheterisation methods.

2.2.1 Common Complications of Intermittent Catheterisation

For some tetraplegics, accessing the urethra may be difficult due to balancing and visibility issues; for example, those with a large stomach and women need to bend over to get a better view. In these cases, opting for a *mitrofanoff* could be beneficial to retain autonomy and avoid an indwelling catheter. A mitrofanoff is an artificial channel, created from the appendix, between the bladder and the skin surface of the lower abdomen. Here the user can self-catheterise through the stomach using regular catheters (Tarm- uro- och stomiförbundet [ILCO], 2022).

Inserting a catheter incorrectly can cause a variety of complications. First off, UTIs are a common issue among catheter users. To minimize the risk of a UTI, the catheter needs to be clean when entering the urethra and therefore the user should avoid touching the catheter tube and make sure it doesn't touch anything before insertion.

The catheter can become blocked due to salt and mineral build-up in the bladder which can loosen, get stuck, and hinder urine from exiting the bladder (Fosnight, 2024).

Enlarged prostates or false passages in the urethra can sometimes cause the catheter to get stuck. Due to the lowered sensation in their hands, tetraplegics cannot feel if the catheter stops moving while inserting it. They may continue to push the catheter and accidentally poke the bladder wall which causes an indentation called a false passage. Pushing the catheter against the urethral or bladder wall can also cause bladder spasms, cramps, and blood in the urine.

2.3 Intermittent Catheter Products

The catheter consists of a tube with a connector piece in one end and draining holes in the other end (see fig. 5). Wellspect's catheter has a hydrophilic surface which become super slippery when activated by water. Exactly how the parts are shaped or lubricated vary between brands.

Catheters are available in different lengths and diameters. Male catheters are 40-45 cm and female catheters are 20-25 cm. The catheter tube diameter is chosen depending on the size of the urethra.

For the catheter to slide easily through the urethra, the catheter must be lubricated to minimize friction. It can either be lubricated with lubricating gel or have a hydrophilic surface which is activated by water. Catheter products can be:

- Uncoated and lubricated by the user.
- Pre-lubricated and ready to use.
- Hydrophilic and activated by the user.
- Hydrophilic, pre-activated, and ready to use.

Some catheters offer a "no touch"-technique which should lower the risk of bacteria getting onto the catheter tube (see fig. 6). One type is a small "sleeve" which can be held with a pinch grip and moved along the tube to stabilize it during insertion. A second type is a full "sleeve", where the tube is completely wrapped. This solution allows the user to grip the whole catheter tube without contaminating it. The design of the no touch-technique varies between brands.

The tube should not touch other parts of the genitals, or anything else, before entering the urethra to keep the catheter free from bacteria contamination. Some brands offer an insertion tip (10-15 mm long) that acts as a

protective barrier. The tip is inserted into the urethral opening before the catheter and lowers the risk of bringing bacteria from the urethral opening into the urethra and bladder.

There are catheter products catering to different needs and lifestyles:

Urine bags are separate plastic bags that are attached to the catheter through the connector piece to collect urine. The bag is later opened to discard the urine in the toilet. This can be useful for situations where a toilet is not readily available or if the user cannot or does not want to urinate directly into the toilet.

Closed system catheters provide an all-in-one solution where the catheter and urine bag are pre-attached and ready to use. This is useful if a user experiences difficulties attaching a urine bag to the connector piece.

Extension tubes are used to provide extra length to guide urine into the toilet bowl They are reusable tubes, which are attached to the catheter through the connector piece. This is useful if a user stays in a wheelchair in front or next to the toilet while peeing. The used extension tube is switched to a new one around once a week.

Figure 5. A catheter consists of a flexible plastic tube with a cone shaped connector at the tope and draining holes (eyelets) at the catheter tip. Here is a female catheter to the left and a male catheter on the right.

Figure 6. Two male catheters with different no touch techniques. The left has a short plastic tube which can be moved along the tube. The right catheter has a full plastic sleeve protecting the whole tube.

Figure 7. Different packaging for male catheters.

2.3.1 A Variety of Packaging Designs

The main purpose of the packaging is to keep the catheter sterile while storing and transporting it. There is a wide range of packaging shapes and materials for catheters which can be seen in figure 7.

The classic packaging shape is a long slim rectangle where the catheter lies straight. A more recent packaging shape trend leans toward being more compact; the desire is to make the product more discreet and easier to put into a bag or pocket. However, the shorter dimensions force the catheter to lie rolled up in the package, which affects the material memory of the catheter tube; it becomes wobbly which makes it more difficult to guide into the urethra. To counteract this issue, manufacturers have used a full-sized sleeve around the catheter which allows the user to hold the catheter tube to stabilize it.

Packaging materials that are commonly used are: paper, plastic sheets, hard plastic, and aluminium. The type of catheter, lubrication or activation type, and required shelf time have an impact on which material is chosen for the packaging. The packaging material also affects the haptic, auditory, and visual sensation from the users.

2.3.2 Assistive Devices Related to Intermittent Catheterisation

There are many assistive devices which help with activities in daily life. When it comes to self-catheterisation there are a few specific assistive devices that can help handling clothes, spread legs, improve visibility, and grip:

- **Pants hook** that holds pants down and out of the way.
- **Leg separator** that keeps legs apart for female users.
- **Mirror** that improves the visibility of the urethra for female users.
- **Penis holder** that holds the urethral opening in the right angle.
- **Catheter grips** for users with low hand function.

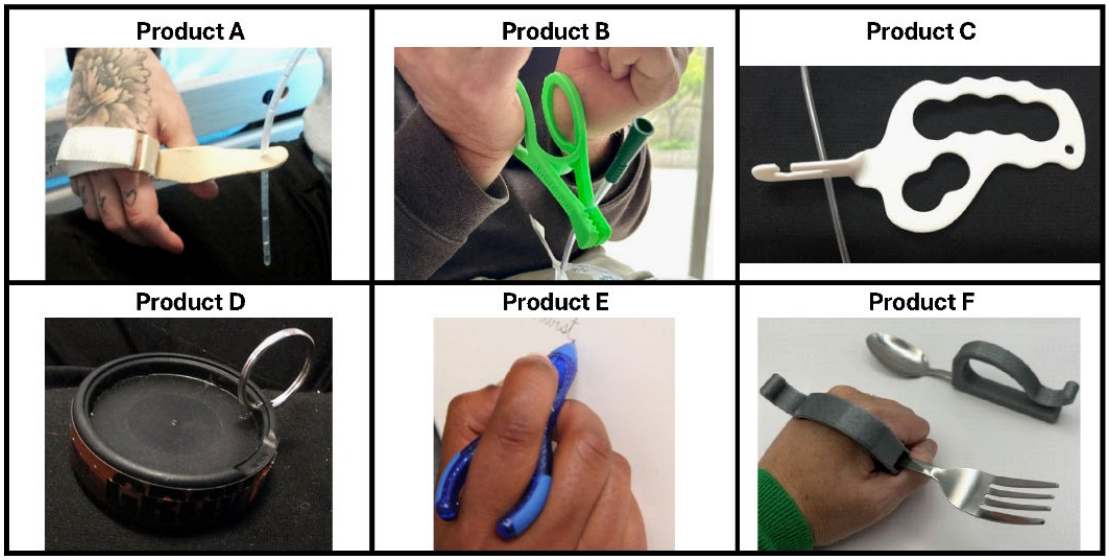


Figure 8. Assistive devices for catheterisation (products A-C) and other activities of daily life (products D-F).

Assistive grip devices seen in figure 8, help to hold and control the direction of the catheter tube when aiming into the urethra opening (products A-C). Other assistive grip devices are also shown to portray common methods to handle everyday objects (products D-F).

2.4 Acquiring an Intermittent Catheter

Intermittent catheter products are used by a wide variety of people; they differ in age, sex, lifestyles, activity level, and cultural backgrounds. It is a diverse group with each person having their own preferences and prerequisites.

Patients who experience a slow onset SCI have more time to learn about the self-catheterisation process and can mentally adjust to the new bathroom process and intermittent catheter products while they still maintain a "good" hand dexterity. On the other hand, acute SCI patients need to more quickly adjust and learn intermittent catheterisation all while adjusting to a completely new life in a *new* body.

Once acute SCI patients need to learn intermittent catheterisation, they are provided a catheter and an assistive device chosen by their urologist or nurse. The urologist or nurse decides which catheter product is most suitable for the patient's prerequisites in that moment. After this, the acquirement process is the same between slow onset and acute SCI patients:

1. Meet a urologist or nurse who presents a variety of suitable catheter products from different manufacturers.
2. The patient makes an informed decision and can test the catheter.
3. Occupational therapists help patients with technique and can custom make assistive devices.
4. Actively practicing with an assistant nurse and/or by oneself at home.

2.5 A Holistic Design Approach to Enhance the User Experience

User Experience (UX) is a part of Human Centred Design and arises when an interaction occurs between a user, a system, and a context (Roto et al., 2011). The concept and term have existed since the 90's when Donald Norman was one of the first to call it "User Experience" (Norman et al., 1995). The goal with UX is to design for pleasure and

value (Roto et al., 2009) which are subjective goals. This naturally means that UX work needs to evaluate subjective elements in an interaction, for example, feelings, time, context, etc. By including these elements, UX becomes a holistic approach to design (Jordan, 2000). However, these elements vary easily and therefore make every user's experience unique (Lallemand et al., 2015; Roto et al., 2009).

To gauge the quality of experience in interaction design, Lauralee Alben defined criteria such as, "How well was the design team grounded in understanding the needs, tasks and environments of the people for whom the product was designed? How was that learning reflected in the product? "(Alben, 1996).

Usability, which is the *"extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."* (ISO 9241-11), is closely related to UX but does not encompass the subjective elements which affect the user's pleasures and perceived value from an interaction. Nonetheless, usability plays a critical part in achieving positive UX and pleasurable products (Jordan, 2000).

2.5.1 Four Types of Pleasures to Design an Attractive Product

To go beyond the limitations of usability-based approaches, addressing *pleasures* in design projects enables designers to holistically adapt products to the users' personality, feelings, and beliefs (Jordan, 2000).

Whether a product is *pleasurable* or *displeasurable* depends on the feelings and emotions which are evoked when using the product in a certain context, according to Jordan (1996). This occurs when a product provides or fails to provide certain benefits to the person who experiences the product.

To structure a design project and analyse the types of pleasures a product may bring, Jordan applies a framework based on the work of anthropologist Lionel Tiger in 1992. This concerns four types of pleasures: physiological, social, psychological, and ideological.

Physio-pleasure concerns the physical aspects when using a product. The product needs to be adjusted to the user group's anthropometrics and abilities, otherwise they will experience discontentment. As a baseline, the product should feel comfortable to use, e.g. the user should not experience discomfort while using it. Since people vary in shape, size and ability, adjustability of a product can provide comfort to a variety of users. For example, adjustable office chairs are suitable for offices where employees frequently switch desks.

If a product already is comfortable, it has the potential to go beyond *comfort* and provide sensations of sensuality. Clothes, for example, can elevate the user's experience by being made of soft and exquisite materials that are pleasurable to touch. Products can in themselves or through their functions provide physio-pleasures through taste, smell, sound, touch, or their appearance.

However, the context in which the experience takes place affects how the product is perceived and if it can be deemed pleasurable.

Socio-pleasure is derived from relationships with other individuals and society. A product can convey a social identity or status which leads to people categorising the user into one or more communities, institutions, or social groups, no matter if it is true or not. For example, a person wearing a Birkin bag on

their shoulder is seen as someone wealthy and socialises with other wealthy people. A product can also create a negative social identity if it somehow causes a nuisance to others. For example, loud mopeds zooming by a spa resort is disturbing for the spa guests.

A product can enable interactions between individuals and even encourage sociability. An example are co-living homes where people share common areas such as the living room and kitchen, while having private bedrooms and bathrooms.

Psycho-pleasure is about cognitive and emotional reactions when using a product. If a product is too cognitively demanding it may make the user frustrated or stressed. Which emotional reaction is desirable depends on the context. For example, a spa resort may use calming colours in their interior instead of bright colours. The latter would make the spa guests more alert rather than calm and relaxed.

A product's pleasurability can be affected by how confident and in control the user feels while using it. To ensure that the user can make use of the product's functions, it's interface should aid in executing tasks in a painless way.

Ideo-pleasure is related to peoples' values that are abstract principles that people hold important and use as guiding principles in their lives. Some examples are sustainability, freedom, humility, efficiency, generosity, autonomy, and abundance. A product may appeal to certain values by embodying them in their design. For example, when dog owners are walking their dogs, they must pick up after the dogs and it is usually done with a plastic bag. Some dog owners may feel guilty about using so many plastic bags because of their negative environmental impact and therefore would be happier to use plastic bags made from biodegradable materials instead. These biodegradable bags help fulfil the need of cleaning up after the dog and at the same time speak to the dog owner's value of environmentalism.

The designer needs to sort the users' characteristics and wants/needs into the pleasure-categories and are then translated into design requirements. Lastly, the solution(s) is evaluated to see if it fulfils the previously identified pleasures.

Ultimately, a product does not need to involve all four pleasures, however the more pleasurable and satisfactory a product is, the more attractive it becomes to users.

3 Phase One: Methods and Execution for Understanding the Users

This study uses qualitative research methods to understand which aspects affect the user's experience when they intermittently self-catheterise with low hand function. The goal is to identify patterns among opinions, emotions, and developed techniques when using today's catheter products. To do so, data was collected using unstructured and semi-structured interviews, one focus group with healthcare professionals (called experts), and one workshop with people who self-catheterise (called users). Additionally, the workshop included methods such as the Geneva Emotion Wheel (GEW), assessing random objects, and word clouds. The data was analysed by using the K-J method and the four pleasure framwork.

3.1 Structure of Study

The study process in figure 9 started with learning about the user group, catheter related products, and the self-catheterisation process. Simultaneously, there was a search for user and healthcare professionals willing to partake in the study. When collecting data, new information was shared which led to more background research. Also, ideas spontaneously emerged and noted while gathering data and learning about the topic. Although some analysation was done continuously, a more in-depth analysation started once the data collection with study participants was done and there was an overview of all the collected data. The analysis was summarised into a few take-away points that acted as a foundation for a more rigorous and focused ideation and concept development.

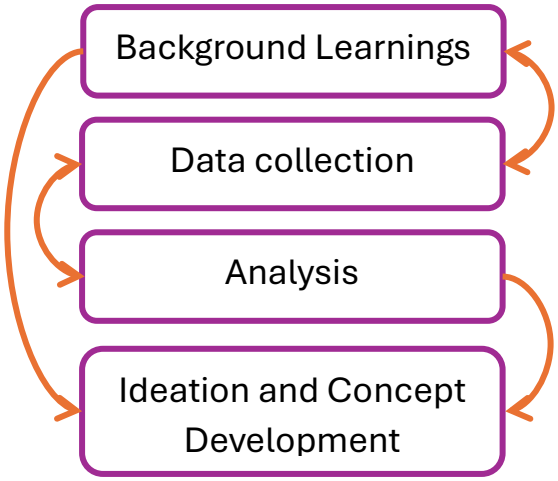


Figure 9. The iterative process of the study.

3.2 Sampling Study Participants

In table 1, a summary of who partook in the study is shown. To start, an internet search was done to find relevant associations, clinics, and healthcare departments who potentially had a network or employees who could be of interest to the study. The associations found were

Table 1. Summary of study participants

Code	Participant type	Study(s)
U1	User	Semi-structured interview
U2	User	Semi-structured interview
U3	User	Semi-structured interview
U4	User	Semi-structured interview + Workshop + Concept feedback
U5	User	Workshop
U6	User	Workshop
E1	Expert	Unstructured interview + Concept feedback
E2	Expert	Unstructured interview + Focus group
E3	Expert	Focus group
W1	Wellspect	Unstructured interview
W2	Wellspect	Unstructured interview
W3	Wellspect	Unstructured interview
W4	Wellspect	Unstructured interview
W5	Wellspect	Unstructured interview

Ryggmärgsskadecentrum Göteborg, RG Aktiv Rehabilitering, The Spinalis Foundation, and Neuroförbundet.

These associations and clinics were contacted by phone or email. Ryggmärgsskadecentrum Göteborg created a social media post to request for study participants on their official Facebook page. RG Aktiv Rehabilitering emailed clients who were suitable for the study. A snowballing effect occurred where other people were recommended to be contacted. This led to eight user and expert participants in the study (U1, U3-U6, and E1-E3). Among the users, only two of the six primary user participants fulfilled all three criteria.

Social media groups were used to find users. These groups tended to be private and only a few allowed "outsiders" to enter. The Facebook group "Self Catheterisation for WOMEN" approved to post a request about study participants, to which a few group members replied to. This resulted in one user participant (U2).

Participants from Wellspect were recommended by the supervisors and contacted via either email or the internal chat system. This led to five participants (W1-W5).

3.3 GDPR

At the beginning of the interviews, focus group, and workshop, the participants were informed about their right to end their participation at any time during the study. This meant that any personal data and contributions would be completely deleted from the study. Once the study was completed in its entirety, all the video and audio recordings were deleted.

3.4 Interviews

Interviews together with users, experts, and Wellspect were held either in person or digitally. All the interviews with users and experts were video and audio recorded, and transcribed. Most of the interviews, except for two, were semi-structured, to collect in-depth data on specific topics and allow flexibility to explore new and potentially relevant topics.

The interviews with users (see table 2) were held digitally where the users could participate from the comfort of their own home. At the beginning of each interview, the study and its purpose were presented. The interviewees were advised to only talk about what they were comfortable sharing. On average, the interviews were 40 minutes long.

The two experts (see table 3) partaking in interviews worked as a urologist or an assistant nurse specializing in pressure bladder management. These interviews occurred spontaneously either over the phone or in person while the interviewee was at their workplace during work hours and were unstructured. They took around 15-20 minutes each. Including experts in the study provided a broader understanding of the variety of needs and prerequisites the users have considering that they meet a wide range of patients.

Five semi-structured, 30 to 60-minute interviews were held with Wellspect employees either in person or digitally (see table 4). The interviews were done in coalition with another student who was working with a separate project to save time. During the interview notes were taken about insights into the company's perspective, their previous experiences, and priorities.

Table 2. The various SCI levels, hand functions, and catheterisation methods among interviewed users.

User	Sex	SCI level	Hand function	Catheterisation method
U1	Female	C8	Good with strength limitations	IC
U2	Female	non (overactive bladder)	Good	IC
U3	Female	C5	Non	Suprapubic catheter
U4	Male	Paraplegic	Good	IC

Table 3. Anonymity codes for expert participants.

Expert	Occupation
E1	Urologist
E2	Assistant nurse, specialist in bladder management
E3	Occupational therapist

Table 4. Anonymity codes for Wellspect participants.

Wellspect employee	Occupation	Comment
W1	Senior R&D scientist	Materials expert
W2	Territory manager, field sales.	Ex-urologist
W3	Production development engineer	Production expert
W4	Head of global platform urology	Marketing expert
W5	Global product manager	Product manager for female catheter made easy to grip

3.5 User Group Activities

One focus group was held digitally with two experts: one occupational therapist and one assistant nurse specializing in bladder management (see table 3). The assistant nurse had partaken in an unstructured phone interview prior to the focus group. The participants, who were coworkers, joined from their workplace while sharing a computer in the same room. The whole one-hour focus group was video recorded and transcribed.

The purpose of the focus group was to, in a structured and engaging way, have a conversation about relevant topics to help the study validate findings, and explore new aspects. A digital tool, "Miro", was used as a whiteboard seen by all participants while the facilitator took notes.

Prior to the real focus group, the effectivity of the digital tool "Miro" was tested with a "pilot"-round where the facilitator asked a random person to engage in a conversation around a pre-decided topic (basketball) via a digital meeting. Notetaking and sharing the screen was tested. Afterwards the person was asked about feedback on how easy it was to follow along, understand the notes, and talk at the same time.

The focus group structure included an introduction, three blocks, summary, and ending (see **appendix A**). The introduction presented the study and the outline of the focus group.

Block one was to discuss how tetraplegics with low hand function manage to self-catheterise today based on the experts' professional experiences. To start off, two

word clouds were shown (fig.10). Words relevant to intermittent catheterisation were chosen to start off the conversation. An assumed user journey was drawn by the researcher and the experts were able to validate, change or add new details to the user journey. Additionally, the aim was to gain insight into which steps in the journey may be more easy or difficult and why.

Block two focused on today's market, e.g. existing catheter products, catheter related assistive devices, and general assistive devices (both commercial and homemade). The experts were presented images from one category at a time and were able to discuss pros and cons about each product.

Block three allowed the participants to speculate about what the ideal bathroom visit would look like for a user.

A workshop was held in Stockholm together with three users (see table. 5), who happened to be colleagues. The workshop was held in a private room at their workplace. Prior to the workshop, an invitation poster was printed and distributed.

Everyone, including the facilitator (who was also the researcher), sat at the same table where snacks were available throughout the session. The workshop was 1.5-2 hours long with a ten-minute break. It was video recorded with a laptop camera and later transcribed. The workshop structure can be found in **appendix B**.

One activity was to converse about general thoughts and memories connected to self-catheterisation. The purpose was to immerse the participants into the right mindset early in the workshop. Three word-clouds based on the five senses, self-catheterisation, and relationships were made and were used at the beginning of the workshop (see fig. 10). The word clouds triggered conversations about the participants abilities and how they handle certain situations.

A second activity was to discuss the different steps in the user journey to understand what the users regarded as easy versus difficult to execute.

A third activity was to measure emotional reactions to objects, events, and situations. For this, the instrument Geneva Emotion Wheel (GEW; see Scherer, 2005; Scherer, Fontaine, Sacharin, & Soriano, 2013) was used. The GEW contains twenty emotion families that are placed in a wheel shape along with axes which demonstrate two dimensions of emotional experience: valence as the x-axis and control as the y-axis. The respondent can choose the intensity of the felt emotions. There is also the option to choose "none" if they felt no emotion or "other" if a different emotion was felt. The original GEW was translated from English to Swedish to be

Table 5. Various SCI levels, hand functions, and catheterisation methods among users participating in the workshop.

User	Sex	SCI level	Hand function	Catheterisation method
U4	Male	Paraplegic	Good	IC
U5	Male	C6	Poor	IC
U6	Male	C6	1 poor + 1 good hand	IC

Figure 10. Word clouds relating to the self-catheterisation experience from different perspectives.

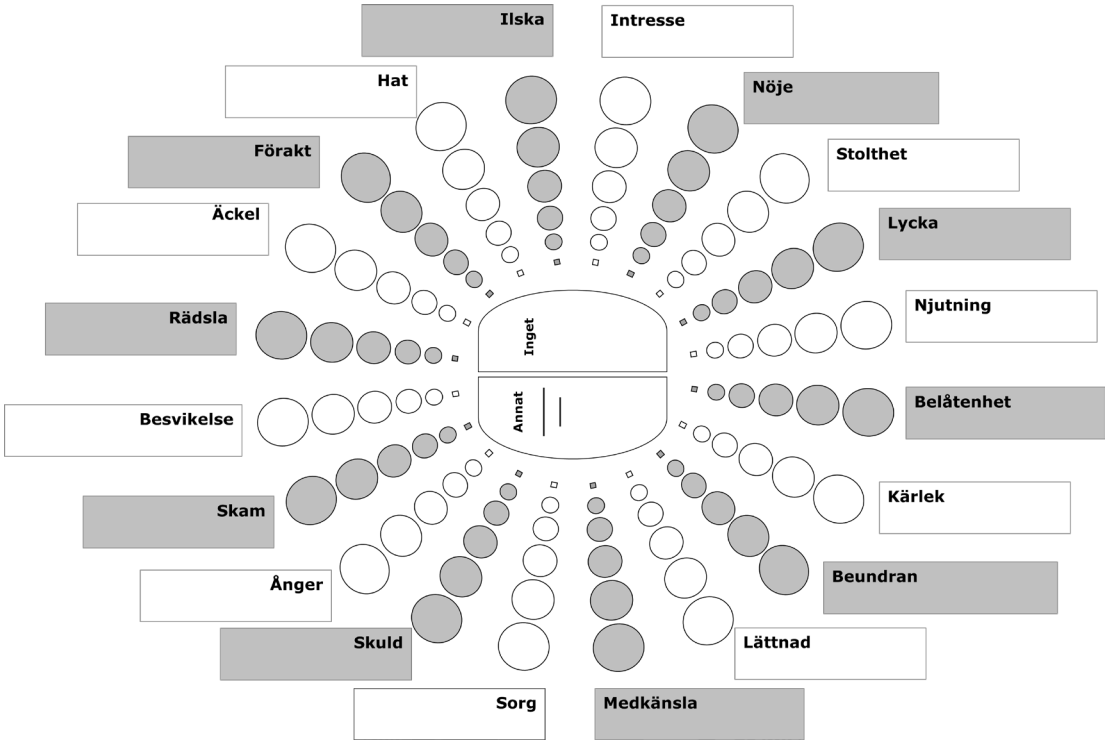


Figure 11. The Geneva Emotion Wheel translated to Swedish. Source: https://www.unige.ch/cisa/gew/

more suitable for the workshop which was held in Swedish (see fig. 11).

The participants U5 and U6 individually filled out separate emotion wheels for four different situations regarding self-catheterisation: their home environment, at their occupation, during leisure activities, and a situation they tend to avoid. As they filled in the wheels, they asked questions to get clarification on what certain emotions meant which also evoked thoughts and short conversations about their experiences in these situations. Once all the wheels were done, the strongest emotions from each situation were discussed to understand where they stem from. The results were compiled and summarized into one emotion wheel.

The last activity was to assess the shape, size, weight, functionality, material, etc., of random objects which had been curated beforehand.

These objects consisted of baby toys, office supplies, garden supplies, medical supplies, and kitchen utensils. The purpose was to gather opinions about what works better or worse for a user with low hand function.

The users were instructed to pick up and feel different objects and provide comments. They were asked questions by the facilitator to get further reasoning. The objects provoked thoughts about what fits well in the hand, what feels secure in the hand, what is easy to carry and what is easy or difficult to pick up. They also compared objects to other everyday items that can be found in everyday life.

3.5.1 Pilot Workshop: Testing Structure and Content

Before the user workshop, a pilot workshop was conducted together with two Wellspect employees and a student. The purpose was to test the workshop structure, content, and practice the facilitator role.

The first block focused on user's experiences in connection to three different word clouds and comment on the user journey. It was a confusing for the participants because they thought they needed to role play as the users. But after redirecting their thoughts by asking questions, they were able to discuss the user's experiences both from their professional perspective as well as a hypothetical user's perspective.

When they filled in the GEW papers, they needed more clarification on what the emotion wheel was and what they were about. Before the final workshop, a short question was written on each GEW paper to clarify what type of situation they need to think about. For example, "What do you feel when you are going to self-catheterise at work, school, or similar?". The participant could then glance at the question while filling in the GEW.

3.6 Visualising Those Who Affect Catheter Usage

A visualisation of those who can help or have an impact on the self-catheterisation was made to get an overview of involved people and organisations, and the relationships between them. This provided a holistic understanding of the eco-system consisting of the person who self-catheterises, their family, healthcare institutions, and how each of these may affect the catheterisation. The map was made based off data from interviews with Wellspect employees.

3.7 Analysis of Collected Data by K-J Method

All the transcribed material was organised and analysed using the K-J method. The K-J method, also known as an affinity diagram, was originally created by the Japanese anthropologist Kawakita Jiro to organise qualitative data into manageable groups. This method provides the researcher both a general overview of the data which facilitates finding patterns, themes, and relationships between groups, as well as an overview of specific details.

The general instructions are to transfer data on to sticky notes and sort them into groups, while being silent. Once all the sticky notes are grouped, titles are developed for each group. When possible, groups related to each other are put in a larger supergroup (Plain, 2007).

For this study, a digital tool "Miro" was used to visualise the analysis which was done in four rounds. Quotes from the transcriptions were transferred on to digital sticky notes and dragged together based on issues or topics. The first round looked at grouping quotes from the interviews, workshop, and focus group together based on similar topics. The second

round aimed to identify themes and relationships between groups. The third round aimed to identify product pleasures. Lastly, round four was about articulating product benefits.

4 Phase One: Result from Understanding the Users

The analysis resulted in a visualisation of those affecting catheter usage, themes, and various product pleasures and product benefits. This provided an overview of people and bodies that directly or indirectly affect the user's catheterisation in terms of executing the catheterisation, learning the process, and product availability and presentation.

Two main themes, *Selfcare* and *Control,* were synthetised from the K-J analysis (see fig. 13). Selfcare encompasses the subcategories the user's *social life*, *health*, and *hygiene*. Control focuses on the user's ability to (personally) control the interaction with the catheter, notably in a cleanly manner. It therefore includes the subcategories *grasping*, *accessibility*, and *hygiene* (the latter overlaps with Selfcare).

4.1 A Visualisation of Who Affects the User's Catheter Usage

In figure 12, various individuals and institutions are presented. The user can have several people in their network who help them manage a life with tetraplegia.

The user is introduced to catheters by a urologist or nurse who preselects catheter products based on the patient's prerequisites. The products should be presented equally, but the HCP's personal bias can affect the presentation and decision making of the patient, says a Wellspect employee (W4). Regarding newly injured patients, one expert (E1) selects catheter products that have a very low cognitive demand. These catheters tend to be pre-wet and easy to open with low hand function. The urologist's or nurse's personal bias can affect which catheters are purchased and stocked in the clinic or hospital and therefore marketing and sales efforts are put

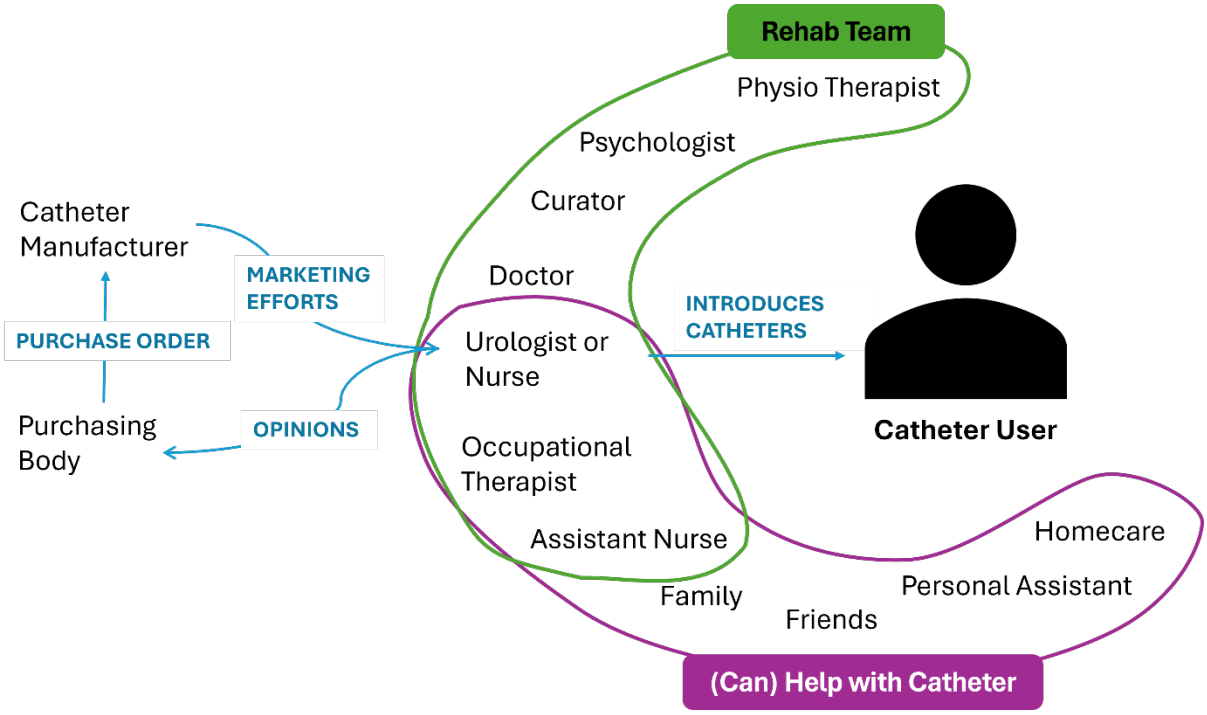


Figure 12. A map of individuals, job roles, and bodies who influence the user's catheter usage.

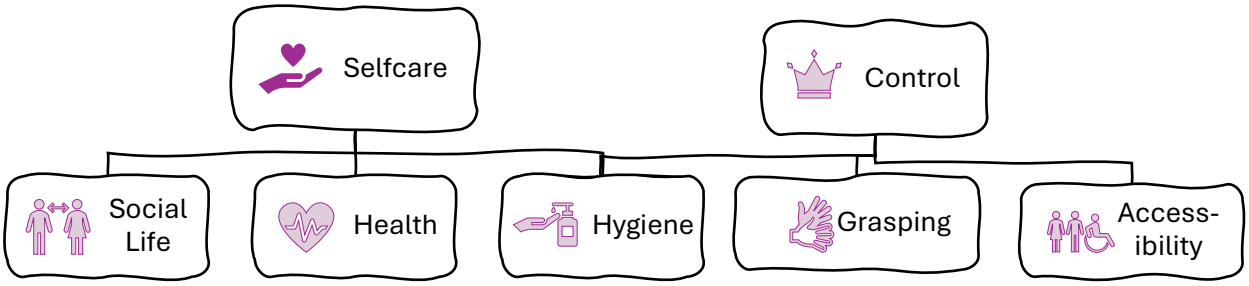


Figure 13. Themes found from the contributions from the study participants.

toward urologists and nurses. Their opinions can be shared to the purchasing body who ultimately makes the procurement decisions.

The user learns catheterisation techniques from the urologist and occupational therapist during appointments. Outside the appointments, acute SCI patients get continuous practice together with assistant nurses at the hospital which helps them cement the new learnings. Slow onset patients practice at home between appointments. Patients only have a limited time together with HCP, so to manage the learning process the catheter product should be easy to teach and easy to learn, says a Wellspect employee (W4).

Users who cannot self-catheterise independently at home can get help from family, partners, personal assistants, or home care providers. They too also need to learn how to handle the catheter product safely.

4.2 Main Theme I: Selfcare

One of the main themes that emerged from the K-J analysis was Selfcare. It is about holistically maintaining and nourishing mental and physical health.

Social life pertains to the desire of wanting to be accepted in society and feeling as one belongs to a *community*.

How someone urinates is not necessarily something everyone wants to communicate to others and therefore *discretion* is important to uphold the feeling of being accepted.

The ability to have an active life, e.g. engage in activities of daily life, both physical and/or social activities can aid in building a positive mental and physical health.

Learning to *handle and trust the body's* mechanics can be challenging when catheterising. But once the user has mastered knowing their body, they will have the mental space to think about other things than catheterisation.

Upkeeping a good *hygiene* helps to maintain a good physical and mental health. But how well a person can keep a good hygiene during catheterisation is affected by the *surroundings* and how well they can control the *catheter products*. Therefore, the subcategory hygiene overlaps with the main theme Control.

Social Life: Community

In the SCI-community there is a sense of non-judgement and trust toward one another, especially when it comes to sharing advice with others who have a similar injury. One user (U1) describes a feeling of responsibility to share their knowledge and experience by paying it forward. A couple users (U3 and U4) engage as mentors to provide support for people with SCIs as well as their family and friends. Especially an acute SCI causes a sudden change in how someone manages

their life, and mentors can help with adjusting one's mindset around how to live a happy life with an SCI. This can act as a motivator to relearn everything with a new set of motor skills, says both a user and an expert (U4 and E1).

"When we meet others, you really want to pay it forward. I feel a great responsibility to share my knowledge, my tips, and advice. The credibility for other people with similar conditions is so great."
– User U1

Social Life: Discretion

When meeting an occupational therapist, the user learns how to be discreet about how they urinate, according to an expert (E3). Both users and experts thought that catheters are something private and should look discreet. Even after the catheter has been thrown away, a user (U6) preferred to conceal it by putting a paper towel on top or place it inside a bag before throwing it.

"You feel like you wear a badge saying, *"IM GONNA SELF CATHETERISE!". If you had it discreet you could just put it in your back pocket and go to the loo"*
- User U2

The users stored their catheters differently. One user (U2) used her handbag where she organized her catheters and everything that she could need to catheterise in one pencil case. The male users seemed to put their catheters under their wheelchairs. During the workshop, backpacks were also mentioned as a common place to store them. However, the workshop participants complained when the catheters were poking out like a "bouquet of tulips" and that most likely a personal assistant had packed the bag in those cases, implying that they are not as concerned about discretion.

Health: Active life

Users have a desire to be able to go out, lead an active life, and not worry about bathroom visits. An expert (E3) talked about a patient who needs a personal assistant to catheterise but found a way to go to the local mall and catheterise independently. The assistant would pre-attach a urine bag to the catheter before the patient left. When he needed to empty his bladder at the mall, he could insert the catheter into urethra by himself. He would store the filled urine bag in a bag to bring home, where the assistant would empty it. This independence made him feel proud and self-accomplished.

"He [the patient] needed assistance, but he said, 'Yeah, but now I can go to the mall' near where he lived, and the assistant could help prepare [the catheter and urine bag] -...- Then he could go out and self-catheterise, and he said, 'YES, I can do it!' It is so nice to be able to handle certain things, you know. It's very important to be able to do the small things yourself. You grow and feel good from it."'
- Expert E3

Outings and travel days mean a lot of preparation for the users; they need to ensure that each location is accessible for their prerequisites. Even their fluid and food intake are adjusted before long travel days to make sure they do not need to go to the bathroom more than needed, says U5 and U6. Catheterising when being on a tight time schedule can be stressful as they worry about being late, for example missing a train or a flight, and catheterising quickly with low hand function can be difficult and result in frustration.

Health: Learn and Trust Body

Learning about one's body and how it reacts provides a sense of control, especially when the user does not have control over other aspects of their life. At the beginning of an acute SCI, the user's bathroom visits are scheduled. However, the goal is to learn how their fluid intake affects the catheterisation frequency so they can adjust the bathrooms visits according to the body's needs rather than the schedule. For example, if it is a hot day and they have not drunk a lot, they do not need to go to the bathroom often.

Another goal with catheterisation is to urinate directly into to the toilet, either by transferring to the toilet or using an extension tube, says an expert (E2). Contradictorily, some users find comfort in using a urine bag because they don't need to worry about aiming the urine into the toilet, and they can keep track of how many ml urine was in the bladder. Another expert (E3) says, measuring the urine amount is useful if the user is experiencing bladder issues, but for some users it becomes an obsession. They have difficulties stepping away from knowing how much they urinated and completely trusting that their bladder has been emptied. Since UTIs can occur from not emptying the bladder fully, some users worry that they did not get rid of every drop of urine. However, this is a matter of knowing the right technique, learning one's body, and trusting it.

"People often ask, how do you know [that your bladder is empty]? You just trust yourself."
- User U2

For some, visual feedback provides a sense of control. A user (U3) had her suprapubic catheter replaced and got an opaque tube which she did not appreciate at all. From experience, she knew the tube could get build-up and she preferred a transparent tube so she could see when it was time to clean it. The occupational therapist E3 also prefers high visibility. When E3 uses fully sleeved catheters on patients, they find it difficult to see when urine starts flowing.

As the users have low sensation in their hands, they cannot feel if the catheter stops moving and may continue pushing and risk injuring the urethra channel or bladder. One user (U5) experienced blood in their urine after trying a new catheter. They were not aware that the catheter was stuck and kept on pushing. However, the catheter getting stuck is a natural part of catheterisation and means that the user needs to relax their muscles. But some occasions the catheter might be poking the urethra channel or bladder, and it is up to the user to learn how their body reacts in normal circumstances to identify when something is going wrong with the catheterisation.

4.3 Main Theme II: Control

The second main theme found was Control. Control is about the user's physical ability to control the catheter products and catheterisation process.

As mentioned, keeping up a good hygiene can be affected by how well the catheter products are controlled. Proper control can minimise the *risk of injuries, UTIs*, and *urine spillage*.

Controlling the product concerns how well the users can *grasp the product with their own hands or with other tools*, such as the mouth or *assistive devices*. *Materials, shapes, and sizes*, all affect how easy a product is to grasp.

Hygiene: Inserting Correctly Without Risking Injury nor UTIs

The risk of getting a UTI is a cause of worry for many users. In Sweden, the focus is on washing hands and using rubbing alcohol to keep clean, says an expert (E2). However, some users tend to get UTIs easily even if they

are strict with their hygiene, says a Wellspect employee (W4). Especially female users have difficulties positioning and inserting the catheter, and might insert the catheter into the vaginal opening instead. Both the cognitive demand and physical limitations pose a problem among female users as they have limited visibility of their genitalia and are forced to put themselves in body positions where they risk losing their balance and fall, just so they can insert the catheter into urethra without touching surrounding skin.

”Sometimes you think ‘Oh, that’s [the catheter] too loose. That’s not fitting’. Chuck it away and start again. So, as long as you’ve got enough catheters… just make sure you’ve got lots. Especially in the beginning you can make mistakes”.
- User U2 about finding the urethra opening

Hygiene: Surroundings

How the surroundings look can affect the ability to keep things clean. Since the user’s attention is spread between keeping their balance, holding their genitals, positioning the catheter directly into the urethra, and being prepared to guide the urine into the toilet, many things can go wrong if the bathroom environment is poorly organised.

In the users’ home environment, they can easily find and reach what they need. An unideal situation, according to a user (U1), are public toilets, where water, paper towels, trash bins may be spread out and far away from each other and the user needs to extend their arms to reach. One user (U2) says it is difficult to find where to place her bag with catheters and sometimes needs to balance it on a small trash bin. Or a toilet stall can be very small, which leaves very little space for the user to reposition properly and increases the risk of bumping into things and accidentally drop the catheter. Especially while travelling, users (U5 and U6) have experienced situations when they had no other option than to catheterise in small bathroom stalls where they couldn’t close the door behind their wheelchair.

“Sometimes you’re not holding it tight enough and you drop it in the loo, you sometimes bump things. You’ve got one hand holding everything open and the other catheterising and you knock your hand on the laundry bin or something and you drop it.“
- User U2

Hygiene: Sleeved Catheter

A sleeve on the catheter allows the user to place it on surfaces, or even drop it without it getting dirty, before inserting it. Especially for HCP, it can be useful to have such a catheter that can be placed on the patient’s bed while they prepare the patient for catheterisation. The experts in the focus group mentioned that the sleeve is useful for low hand function because the user would not need to worry about where they were holding it and still get a good grip. However, two users (U4 and U5) disliked sleeved catheters for tetraplegics. U4 had noticed that it requires both hands to insert, which is something to be avoided for tetraplegics. But from an expert’s (E3) perspective, tetraplegics tend to dislike sleeved catheters until they have learned the technique.

Hygiene: Urine Spilling or Splashing

Learning intermittent self-catheterisation includes learning various techniques for different parts of the process, with the help from an occupational therapist. The user can spill urine when they do not position the catheter or extension tube into the toilet quick enough, open a urine bag, or do not empty the catheter tube fully before pulling it out. One

user (U5) had developed their own technique to avoid getting urine on his lap:

“Mine [extension tube] is longer so it can reach [the toilet]. But the downside is when you’re done and are going to remove it. Then there is liquid left in the catheter and some in the tube... and you want that down the toilet. And then it can come on your lap if you do it wrong. It gets folded at the connector. So, you have to pull it out quickly. One quick pull at the end. Then it works.”
- User U5 about a technique to pull out the catheter without spilling urine.

When it comes to extension tubes, there is a risk that the tube turns around “like a snake” once urine starts flowing through it, making it behave unpredictably. An expert (E3) recommends their patients to put the tube under the toilet seat to make it stay in place.

Hygiene: Throwing Catheters in the Trash

For the users participating in the study, cleanliness and discretion seemed to be of importance no matter if they were at home or in public. They would make sure to make the package as small as possible and may even put a paper towel to cover it in the trash. The catheters that the users (U4 and U5) used (they used the same brand and model) lied in an aluminium package which was easy to twist and bend as it would keep the new manipulated shape. When throwing it in the trash, they would fold the package and secure the fold by twisting it. Sometimes, the sharp edges would cut their skin, causing them slight discomfort – but not enough to stop them from this habit of keeping things neat and tidy. Making the whole catheter, including the package, as small as possible so it would not be so visible in the trash can is preferable, according to the workshop participants.

"Fold it [the used catheter in the package] up nicely so it doesn't take up much space in the trash can. That way it won't look like a bouquet of flowers."
- User U5

An expert (E3) noticed a difference between female and male users and mentioned that women tend to do it more neatly, while men might not even bother putting the catheter back into the package before throwing. They believe this is due to early developed habits from handling menstrual products.

"As a woman, you are more used to handling tampons and pads. You learn early on to fold them and wrap them in toilet paper. Men, especially, are much worse at disposing of catheters. They [the catheters] often end up sticking out of the trash bag like a damn bouquet because they are bad at putting them back [in the package], and it's disgusting when they aren't in the packaging. It's just a bunch of damn bacteria. THAT is something that should be made easier - to repackage."
- Expert E3

For a user (U1), it is also important to consider the odour a used catheter can create, especially when they are borrowing someone else’s toilet. They would either rinse everything before throwing or bring the catheter with them in a bag to throw elsewhere. This behaviour could possibly stem from worrying about bothering others with one’s personal hygiene.

Grasping: Hand Grips

Throughout the study, different grips were mentioned and used. The most common one was the tenodese grip which is controlled by flexing the wrist. However, the tenodese grip could vary in strength and tightness, says an

expert (E2). They continue to say that everyone is different, even if they have the same level of SCI. Other mentioned grips were the pencil grip, which a user (U5) liked to use for catheterising, and weaving.

The difficulties coupled with low hand function were squeezing, unscrewing, and picking up small pieces. A user (U5) found loose pieces annoying because they would need to find a place to put them, and then pick them up later again. Also, squeezing a water sachet to activate a catheter is not easy. Users need to lay the sachet on a surface and smack it with the palm of their hand instead of squeezing. When other catheter options, that are pre-wet or pre-lubricated are available, the users tend to choose that option.

" I wish the cap was attached like on drinks [beverage packaging] nowadays. When I take it off, I have to put it somewhere. It would be even more convenient. Otherwise, I have to put it somewhere and then keep dealing with it."
- User U5 does not like dealing with small loose objects when catheterising

When self-catheterising, users may need to use both hands to guide the catheter into the urethral opening, which a user (U5) needed to do. Using two hands to execute one thing is not desirable according to an expert (E3), since it is useful to use one hand to direct the urine into the toilet. However, users may still need to use both hands to insert the catheter and need to somehow ensure that the urine is directed into the toilet once it starts to flow. Those who use both hands should feel safe that the extension tube does not slip out of the toilet while inserting the catheter, says a user (U4), and emphasizes the importance of ensuring that the extension tube stays in place.

An important barrier to self-catheterizing is the inability to attach urine bags and extension tubes independently said both a user and experts (U4, E2, and E3). Although many users can catheterise themselves, they may still need assistance to attach a urine bag or extension tube since it requires a pinch grip combined with strength to attach the two pieces together.

"Many have difficulty attaching the bag or tube to empty into the toilet, so that's often the problem for them. - ... - But then I've had some guys who have been able to use this [catheter with a thick handle]. Because the handle is so thick, it's been easier."
- Expert E3, saying that the thickness of the handle can improve grip

"The problem with poor hand function is that you can't connect the catheter with the tube. You're just holding two plastic pieces with open hands; you can't get it in."
- User U4

Grasping: Other Tools Than Hands

When the hand grip does not suffice, users find other strategies to manipulate objects. Very often they use their teeth to hold, pull, and tear. Using the mouth for certain steps in the catheterisation process is recommended by the occupational therapist E3, but not all patients are open to putting things in their mouths, especially not catheter products. For some patients, their mouths help them be independent and is worth the risk of getting urine in their mouths.

"He even tore the urine bag [with his teeth]. It doesn't feel hygienic. But that way, he could still be independent."
- Expert E3

For the most part, opening catheter packages and attaching urine bags or extension tubes may require teeth unless there are holes to hook their finger into. Users complained how the plastic films on the package tend to stick to each other, which was especially aggravating when they were in a hurry. The frustration and worry about not being able to catheterise quickly enough induced stress and make the catheterisation process even more cognitively demanding.

Grasping: Assistive Devices

Patients are shown assistive devices to help hold the catheter when inserting it into urethra. A few catheter manufacturers provide them to make it easier to use the catheters. However, throughout the study the attitude toward assistive devices has been negative because their purpose and usefulness end once the user figures out how to manage without them. Users do not want to feel dependent and feel that they need to bring gadgets with them wherever they go. If the user wants and needs an assistive device, oftentimes they get it customized since the commercially available products do not suit the wide range of grips, strength abilities, and preferences among this user group.

"Then you only need to move your arm, and the catheter is in. But it [the assistive device] is also useless because the catheter often pops out. You often need a [urine] bag too, and the bag doesn't fit in the small holder. It has some advantages, but it's unreliable."
- Expert E1

"For me, it [the clamp] doesn't become an extra hand. Instead, it becomes an extra step."
- User U5

"You don't want to bring a whole trailer of aids with you. You should have simple things that you can easily take with you, things you really need. Ideally, it's perfect if it's integrated."
- Expert E2

The need for assistance changes as the injury progresses. An expert (E1), who meets with acute SCI patients, chooses catheter products with the lowest resistance when the patients are newly injured. Catheterisation should be as easy as possible in the beginning, both in terms of strength requirement and number of steps. While at a later stage of an injury, the user may have developed new personal techniques and understanding of their own personal preferences through experience. The expert continues to explain that the catheter the patient chooses depends on what stage they are at physically and mentally. Once acute SCI patients get used to their new life, it is easier to have a shift of mindset and see things from a new perspective since everything won't be 'new' anymore.

"We help the patients quite a lot in the beginning. Then the whole mindset develops - you land a little more in your injury and your new life. Then you might suddenly see other advantages in other products, so then they [patients] get to see the catheter selection in a different way when they get home."
- Expert E1

Both users U5 and U4 used extension tubes. U5's extension was longer (ca 60 cm) because it needed to stay in the toilet while they aimed and inserted the catheter into urethra with both hands. U4, on the other hand, had a shorter extension (ca 40 cm) because they aimed it into the toilet with one hand and inserted the catheter with the other hand. An expert (E2) and a user (U6) mention a method to create a male catheter package into an extension tube. After opening the package, the user rips off the end on the other side of the

package which creates a tube. A user's (U6) acquaintance did this because they had a visceral response to tubes, making it difficult to use a regular extension tube.

According to a user (U4), many women, use male catheters as both catheter and extension tube. Since the female urethra is shorter, most of the male catheter stays outside and can act as an extension to the toilet. However, accidentally pushing the catheter too far may damage the bladder – a risk worth taking for some.

"Many [female users] use male catheters -...- the male one does not need to be connected to an extension because it is so long. So, when you jump forward and insert the catheter a decimetre, a bit sticks out [of the urethra] and you can position it. The problem is that if you push it in too far, it will hit the roof of the bladder, and you can injure yourself."
- User U4

Grasping: Material Properties and Size

As a user (U5) was comparing items during the workshop they expressed that "the more grip friendly, the better". They demonstrated how slick objects would slide out of their hand when shaken. Also, the size and shape mattered. Upward cones laid securely in the hand, while downward cones slipped out of their grip, according to them. The size should not be too small, as it would fall out of their grasp, or even impossible to pick up. They described that if they dropped a coin, they would not even try to pick it up. U5 expressed that keyrings, which they use to improve the grip on everyday items, or anything where they can insert their fingers make it easier to control an object and it was even better when several fingers could be used.

Looking at the catheter tube itself, stiffer tubes are easier to predict how they move and therefore easier to aim. On the contrary, stiffer tubes are more difficult to navigate around the prostate and can more easily injure the urethra canal. When U5 started using the catheter they have today, they felt that the stiffness caused him pain. After a while they got used to it and appreciates how easy it is to aim. Another user (U1) shared a tip to make "flappy" catheters stiffer, pouring cold water on them.

Two users (U2 and U6) like when catheters use minimal space, both for discreetness and for storage. U2 liked that their catheter was small enough to fit into a pencil case. U6 uses two different catheters: one for home and one at work or for outings. Their work catheter, which they showed at the workshop, was compact and extended upon pulling off a lid, making it easy to store under their wheelchair without bending the package.

" I like that it [the catheter] takes up little space. I don't want a backpack... sometimes when you go to work you see that they [other catheter users] have a thousand tulips [poking] out of their bag"
- User U6 about carrying catheters

During the workshop, the users talked about wanting to avoid using too much material which was an incentive for them to not use urine bags daily. Environmentalism was also a motivator for a user (U2) when they catheterised in public toilets, they would bring home the catheter in a bag to recycle them.

Accessibility

A significant barrier to independent self-catheterisation is the visual access of the urethra opening. Physiognomic conditions such as body weight, size, and balance affect how easy it is to see the urethra. People with SCIs have lowered balance and need to reposition themselves when catheterizing to

avoid falling. Female users need to reposition more compared to male users to gain access to the urethra and at the same time keep their legs apart. Many female tetraplegics with capable hand function for self-catheterisation are given suprapubic catheters because they simply cannot access their urethra, says an expert (E1) begrudgingly.

"It's like that when you have a high SCI, you have very impaired balance. So therefore, you have to sit with okay balance. They normally cannot sit without holding on somewhere. They always have to hold on with one hand and then they only have one hand left."
- Expert E3

4.4 Geneva Emotion Wheel

The summarized emotions from the workshop are displayed in the emotion wheel in figure 14. The emotions are divided into quadrants where the first quadrant contains pleasant and high control emotions. The second quadrant shows pleasant and low control emotions. The third quadrant shows unpleasant and low control emotions. Lastly, the fourth quadrant shows unpleasant and high control emotions.

The most common emotions are in the unpleasant and high control quadrant. Below are descriptions about where the emotions stem from and what the development of the concept can consider.

Pleasant with High and Low Control Emotions

(1st and 2nd Quadrants)

These pleasant emotions pride, pleasure, and relief occur both during and after the catheterisation.

Pride: The user may experience pride after the catheterisation because the process itself can be physically and mentally challenging. Getting through the process can feel as an accomplishment, especially outside the home environment.

Pleasure: Both during and after the catheterisation, the sense of satisfaction of relieving oneself is pleasurable. It always feels good to empty the bladder and not feel the need to go to the bathroom. In those occasions where the user is feeling autonomic

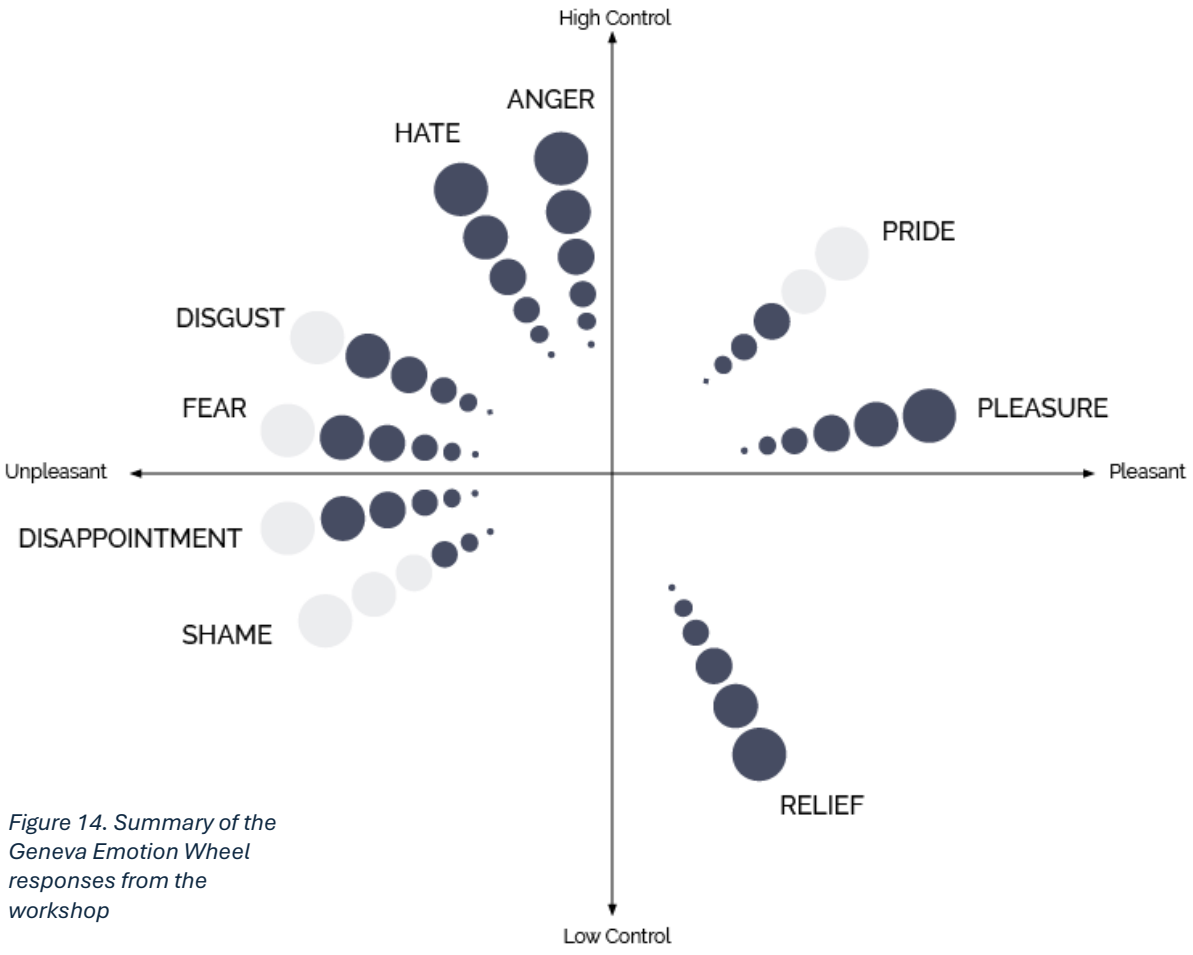


Figure 14. Summary of the Geneva Emotion Wheel responses from the workshop

dysreflexia symptoms, relieving oneself feels even more pleasurable.

Relief: The user feels relieved when they have everything they need to catheterise and know where to find it. During the catheterisation the user does not want to spend their cognitive efforts on taking care of loose pieces and may therefore prefer catheter products without loose lids, sachets, or gloves.

"Home is home. Then I can find [everything]."
-User U6

Unpleasant with High and Low Control Emotions
(3rd and 4th Quadrant)

These unpleasant emotions shame, disappointment, fear, disgust, hate, and anger affect the user before, during, and after the catheterisation. The emotions *shame, disappointment,* and *fear* arise exclusively in contexts outside of the home environment where the user has little control of their surroundings. For example, they are sometimes forced to catheterise without proper privacy because of poorly accessible bathrooms. *Disgust* and *anger* are experienced both in and outside the home environment and are often coupled with difficulties catheterising or urine spilling outside the toilet.

Shame: Occurs when users have no choice but to catheterise in public environments. The physical surroundings affect how easy it is to catheterise, both mentally and physically. The users do not want to draw attention to themselves while catheterising, having questioning gazes from surrounding people. In those moments, it is crucial that nothing goes wrong so the user can quickly finish catheterising. It is a situation where the user may get stressed which can affect how cognitively demanding the catheterisation is.

"It's a little undignified. You have to go through the whole passage, then they usually block off two toilets. Then you have to sit there. It's not like you close yourself off and are by yourself. I can't even get all the way in.
- User U5 about catheterising on an airplane.

Disappointment: Users need to ensure before leisure activities that the bathrooms are accessible. Sometimes, after everything is checked, they arrive at the destination to realize there has been a miscommunication or misaligned expectations on how an accessible toilet looks like.

Fear: There is a fear of accidents, especially when they do not have easy access to toilets. Long travels require the users to plan their diet and avoid drinking too much which leads to dehydration and potentially autonomic dysreflexia symptoms.

"You sip a little water. You get so dehydrated. You do everything not to sit and be worried on the plane. I get such chills [autonomic dysreflexia symptoms]. Then it can be – 'shit, is it the sit bones or something else?'"
- User U6

Disgust: This emotion is experienced when urine spills or splashes onto the user which happens wherever they catheterise.

During leisure activities with other catheter users, they find the trash cans being messy with catheters poking out of the trash bin.

Hate: U6 expressed an intense frustration about every scenario outside of home. Making sure different locations are accessible and constantly being disappointed made U6 feel hate.

Anger: This emotion is coupled with disappointment and disgust. Anger sometimes emerges as irritation. The users

can become irritated when the catheterisation does not go as planned, especially when they are in a hurry. Other times, they become irritated when they spill or splash urine on themselves.

"Hm... irritation. Maybe you can take that as anger. Sometimes it's a bit rushed and much... then you can become 'Hell, come on then!'. It can be a struggle sometimes. "
- User U5

From this summary of the GEWs, it can be said that the unpleasant emotions are often experienced before and during catheterisation where users do not feel assured of the accessibility of toilets, often outside the home environment. The pleasant emotions are what the users strive for when catheterising. Regarding the development of a concept to facilitate self-catheterisation, the concept should enable the user to effectively and efficiently catheterise in situations where they experience unpleasant emotions, without the emotions cognitively impairing the product's ease-of-use. In other words, the concept should be easy to use even in high stress contexts so the user can experience pleasant emotions as quickly as possible.

4.5 Identified Product Benefits to Create a Pleasurable User Experience

After using the K-J method to analyse the data, the data was analysed through the lens of the four-pleasure framework. To get an overview of the user group a few points regarding their characteristics were mapped out. However, it must be noted that the user group encompasses a wide array of ages, lifestyles, genders, and cultural backgrounds and therefore the individuals within the group may have many differences between them. Their similarities are shown in table 7 below.

Ideo characteristics

- Live as independently as possible.
- Stay healthy.
- Have confidence
- Care for others (especially with those with similar experiences)
- Environmentalism

Socio characteristics

- Family and partners assist.
- Strong sense of helping each other.
- Attending leisure activities: sports, parties, clubs, etc.
- Social label "someone who urinates differently"
- Since it is a product that most likely will be hidden, it should focus on how it makes the user feel about themselves

Physio characteristics

- Low hand function
- Stiff fingers
- Difficulty isolating finger(s)
- Grips: tenodese, pencil, hooking finger(s), etc.
- Pre-grip preparations
- Mouth used as tool
- No core strength = poor balance
- Many uses wheelchairs
- SCI changes over time
- Adapted clothing for easier access
- Temperature affecting hand function
- Surroundings can be dirty with no access to water and soap.
- Smell, vision, and touch may be lowered or gone.

Psycho characteristics

- Can have cognitive challenges due to SCI.
- Initial fear of inserting catheter in urethra.
- Lower confidence in early stages of SCI
- Building confidence as experience and injury acceptance increases.

Table 6. Characteristics for intermittently catheterising tetraplegics with low hand function.

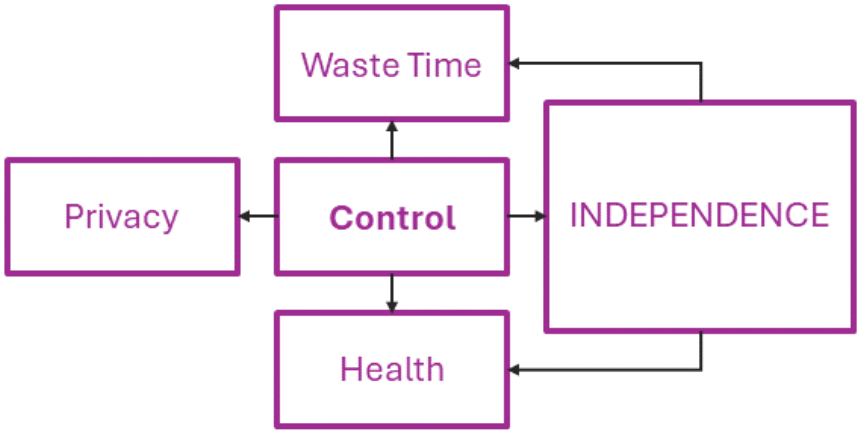


Figure 15. Main product pleasures deducted from user experiences directly or non-directly connected to self-catheterisation.

From the data insights several pleasures and product benefits were identified (see tables 8 to 12). It was found that the users valued *independence, not wasting time in the bathroom, protecting privacy, being physically and mentally healthy,* and *the ability to control the product interaction*. In figure 15, the relationships between the pleasures are shown.

Independence is what the users strive for, but they cannot achieve full independence unless they cannot control the catheter product. The ability to control the catheter product can make the catheterisation process more effective and efficient and the user can spend less time at the toilet. Controlling the catheter properly also enables the user to safely catheterise and help upkeep a good hygiene. Having independence has a positive effect on the user's mental health as they gain confidence in being proficient handling basic needs. The ability to control the product may enable the user to manipulate the product in such a way to affect its discreetness, which is extra useful in social settings.

4.5.1 Striving Toward Independence

Independence is the most important value among users because they are willing to sacrifice other values if a catheter product provides them independence. A product providing the ideo-pleasure of *independence* will be attractive since it means the users can execute a highly intimate activity without the presence of other people. Occasionally, even independent users are in a situation where they need to ask for assistance from someone who is not used to catheter products. It puts both the user and the other person in an awkward situation because catheterisation is such an intimate process which not everyone is comfortable doing. User U2 shared an experience of when they needed assistance from their spouse who refused to help because they were too scared of making a mistake.

It is assumed at Wellspect that the users need more features and bulkier products to handle them independently. But, if the users could choose freely, they want to avoid using catheters with too many extra features, says E1. Many users are becoming more

environmentally aware and care about the amount of material their single-use catheters use which pertains to the ideo-pleasure *environmentalism*. However, E1 continues to say that if those catheters are the only way for them to gain independence, users will still choose them even if it goes against their environmental values. And the same thing goes for the ideo-pleasure *cleanliness*. Some users prefer opening urine bags with their mouths because it helps them to be independent even if they risk getting urine on themselves.

Assistive devices can be practical to facilitate different steps and to have some independence in the user journey. Even so, users strive to manage without them by learning new techniques. Ironically, some assistive devices require assistance for the users to use which goes against the value *independence* and can cause displeasure.

Table 7. Product benefits from "Striving Toward Independence".

The product should enable a more independent life.	IDEO
The product should enable independent self-catheterisation.	IDEO
The product should enable one or several tetraplegic grip options, including the mouth, throughout the user journey.	PHYSIO
The product should not require a strong grip or finger strength.	PHYSIO
The product should only have necessary features to fulfil the user journey.	IDEO
The product should use environmentally sustainable materials.	IDEO

4.5.2 Controlling the Interaction with a Product

In general, users want to feel and be in control when interacting with a product. Because of the lowered hand strength and dexterity, one or several actions in the catheterisation process are difficult or impossible to do. The actions with today's catheter products are not adjusted to the user's grip prerequisites which forces the user to ask for assistance. Many catheter products do not enable the users to control the catheter, purely because their designs disable them from using it properly. Many users do not transfer to the toilet and therefore need to attach a urine bag or an extension tube to the catheter, which user U4 describes as inserting a slim cylinder (like a straw) into another slim cylinder with two open hands. This specific action can disable some users from experiencing a fully independent self-catheterisation.

A consequence of an SCI can be loss of sensation in the hands. Regarding catheterisation, loss of sensation makes it difficult to notice if the catheter gets stuck (physio-displeasure). The users are at risk of hurting their urethra or bladder if they continue to push when the catheter is stuck. Without the ability to take in haptic feedback, the users do not have full control when catheterising. Therefore, other types of feedback can help the user know if the catheterisation is done correctly, an example is when urine starts to flow. The flowing urine is a visual indication that the catheter has reached the bladder. If there is blood in the urine, it indicates that something might have been injured.

To insert the catheter, the user needs to be able to predict the catheter's direction and behaviour. There is a relationship between the "ease-of-insertion" of a catheter and its stiffness. The stiffer the catheter, the easier it is to position into the urethral opening. There is also a relationship between the catheter's stiffness and the risk of injuring the urethral wall. The more flexible a catheter is, the easier it can follow the urethra channel without

poking and injuring the urethral wall. For the users, it is a challenge to insert and position the catheter, keep their balance and their arm up, and not touch the catheter tube at the same time. The users need to find the right balance between flexibility and "ease-of-insertion" when choosing the right catheter product for them.

When a user faces a situation where they are in a hurry it is crucial that they can catheterise quickly, for example if they are feeling intense autonomic dysreflexia symptoms from a full bladder. Today, the user journey feels long and tedious where additional objects, such as assistive devices, urine bags, or extension tubes, need to be added, thus making it

The product should enable tetraplegic grip options in every step of the user journey.	PHYSIO
The product should not require grip strength.	PHYSIO
The product should not require finger strength.	PHYSIO
The product should enable a secure grip through either shape, size, and/or material choice.	PHYSIO
The product should not slip out of grip unintentionally.	PHYSIO
The product should not be so sharp that it could cut skin.	PHYSIO
The product should not cause discomfort if pushed against the body.	PHYSIO
The product should not rely on haptic feedback.	PHYSIO/ PSYCHO
The product should enable the user to know when to stop moving the catheter.	PSYCHO

Table 8. Product benefits from "Controlling the Interaction with a Product".

Another aspect of being in control is knowing when to stop inserting the catheter further or pulling it out. The user knows this when they see urine starting or stopping to flow. Therefore, visual feedback is important aspect to psycho-pleasure

4.5.3 Not Waste Time in the Bathroom

Users do not want to spend longer time than necessary in the bathroom. The desired experience is to get as close to a "normal" bathroom visit as possible. The user journey therefore needs to be effective with a potential for efficiency. This means that the product interaction needs to be easy: easy to learn, easy to use, and easy to teach. Going to the bathroom should not require conscious effort but rather be a spontaneous action, almost as if the user relies on "muscle memory" when catheterising.

difficult to catheterise quickly. Both users and experts have expressed feelings of frustration and anger about the process not being optimized. Users who are capable of self-catheterising may still need assistance to handle these extra objects. Expert E1 says that any extra object that needs to be added to the process can create feelings of worry because more things can go wrong. This causes the user displeasure when they are uncertain whether the process will be effective or not.

A package that is easy to open, with everything included and no small loose pieces aresome of the important attributes that have been mentioned to be desirable in the study (psycho- and physio pleasure). Knowing where everything is and with fewer things that can go wrong provides a sense of relief and calmness which provides psycho-pleasure. The product benefits from this section can be found in table 9.

4.5.4 Protecting One's Privacy

Keeping their privacy before, during, and after the user journey is important for users. A discreet catheter product adheres to this ideo-pleasure so the user can avoid unwanted attention. Different product elements such as shape, colour, sound, and smell can contribute to the perceived discreetness. But most importantly for catheter products is the visibility of the product's intended use. Before going to the bathroom, the user wants the package to be of a discreet size, so it is easy to stow away in a bag or a pocket, and the catheter to be hidden. Afterwards, when the catheter is lying in the trashbin, it should not be sticking out of the bin nor give off an odour.

In a social context, people may view the users differently because they use intermittent catheters. Occasionally, the users have no choice but to catheterise without full privacy and in a public setting. Onlooking people may start questioning what is happening. This is a stressful situation for the user, and as previously mentioned, it becomes extra important for the catheterisation to be effective. The product benefits are found in table 10.

Table 9. Product benefits from "Not Waste Time in the Bathroom".

The product should make the bathroom visit as short as possible.	IDEO
The product should be easy to learn.	PSYCHO
The product should be easy to teach.	PSYCHO
The product should require very low cognitive demand, especially if used in early stage of acute SCI.	PSYCHO
The product should not require so much cognitive demand it becomes difficult in stressful situations.	PSYCHO
The product should be suitable for changes in preference and skill as the user gains experience.	PHYSIO/ PSYCHO
The catheter should be ready to use without activating or adding lubrication.	PHYSIO/ PSYCHO
The product should not be an extra element to be added every time the user self-catheterises.	PSYCHO
The product should not have loose parts that are difficult to pick up.	PHYSIO/ PSYCHO
The product should include all necessities to fulfil the activity.	PSYCHO
The package should be easy to open.	PHYSIO/ PSYCHO
The product should be reliable.	PSYCHO
The product's behaviour should be predictable.	PSYCHO

Table 10. Product Benefits from "Protecting One's Privacy"

The product should be discreet before, during, and after the user journey.	IDEO/ SOCIO
The product's semiotics should not give away it's intended purpose.	IDEO/ SOCIO
The product should not be noisy.	PHYSIO/ SOCIO
The package's shape and size should be easy to manipulate	PHYSIO
The product should take up minimal space when being disposed.	PSYCHO/ SOCIO
The product's size should not make the user worry about fitting other things in their packing.	PSYCHO
The product should not increase bad odour	PSYCHO/ SOCIO

Table 11. Product benefits from "Being Physically and Mentally Healthy".

The product should make it easy to practice cleanliness and personal hygiene.	IDEO/ SOCIO
The product should be easy to use in a clean manner, even in a dirty environment	PHYSIO/ PSYCHO
The product should be easy to throw neatly.	PHYSIO/ PSYCHO
The product should encourage neat disposal.	PHYSIO
The product should enable tetraplegic grip options that make it easy to avoid touching the catheter tube.	PHYSIO
The product should provide a sense of control.	PSYCHO
The product should make the user feel like they are taking care of themselves.	IDEO

4.5.5 Being Physically and Mentally Healthy

Several aspects connected to *being physically and mentally healthy* were distracted from the study: cleanliness, personal hygiene, knowing one's body, and being a part of a community.

The users are taught to avoid touching the catheter tube but can sometimes experience difficulties handling the no touch-techniques that are provided today. Partial sleeves tend to require a pincer grip to move up and down the catheter tube, which the users cannot do. Therefore, users feel that it is useless and an obstacle. Full sleeves force the user to use two hands to feed the catheter into the bladder. However, the catheter stays clean if the user drops it or needs to hold the catheter tube to position it into urethra more easily. Closed systems also need two hands to insert, but the user does not need to worry about aiming the catheter into the toilet since it is already attached to a urine bag which makes it feel less cognitively demanding.

Keeping things tidy and neat relates to throwing away the catheter in a hygienic manner by putting it back in its packaging and folding it together. Some women may have a mental model from handling menstrual products which can be wrapped in toilet paper

and/or put in a plastic bag before being disposed.

Regarding personal hygiene, users want to smell nice because they do not want to be related to the smell of urine and perceived as someone who lacks hygiene. The risk of getting a urine splash or spilling urine on oneself is always there when self-catheterising, especially when pulling out the catheter and opening a urine bag for tetraplegic users.

Learning the body's new behaviour after an SCI can be helped by documenting urine data. It can help the user understand why they may experience cramps or still feel a need to urinate even after they have catheterised. As mentioned during the focus group, some users become obsessed with keeping track of how much urine was in their bladder, because it gives them a sense of control. The sensation of lack of control of one's body mechanics can lead to seeking control elsewhere; logging urine data is then an easy way to feel control.

In the SCI community, knowledge sharing is highly valued, and the members feel a desire to share their experiences and practical tips with other members. This is done at in-person meetups through various organisations as well as on social media. If a catheter product can fulfil the user group's values and create most of the wanted product pleasures, it will increase the chance of it gaining popularity within the community through word-of-mouth since the community members are so inclined to helping each other.

4.6 Analysing the Bathroom Visit

Today's user journey (fig. 16) depends on which catheter products are used, the user's sex, and if it is done on the toilet seat or elsewhere. Other variables such as the catheter's activation type, open or closed system catheters, and assistive equipment also affect the length of the user journey. The journey has been divided into three stages: *Open*, *Execute*, and *Throw*. Below is a short description of the stages and related issues that have been revealed in the analysis.

Stage Open includes opening the package and making the catheter tube slippery. Manually lubricating or activating a catheter with tap water, water sachet, or lubrication is extra time consuming for the users, compared to people with high hand function. They tend to prefer pre-lubricated or pre-activated catheter products.

Opening the packaging sometimes requires pulling apart plastic films which tend to stick together. If there are no holes to insert fingers, the user needs to find other ways to separate and get a good grip of the plastic films, for example with their teeth.

Stage Execute includes attaching a urine bag or extension tube, holding the catheter, aiming, inserting, emptying bladder, and pulling out.

Due to the lack of a pincer grip, attaching extension tubes or urine bags can be near impossible for most users and they may need assistance for this step. Assistance may also be required to attach assistive devices. This adds to the time spent in the bathroom.

While inserting the catheter, many users need two hands to guide the catheter and ensure it is directed into urethra without touching surrounding skin. With both hands occupied, directing the urine into the toilet once the urine starts to flow becomes challenging. This can be a reason why some users prefer urine bags as opposed to extension tubes. On the other hand, this stops them from reaching the goal of urinating directly into the toilet.

If the catheter gets stuck, it will most likely be discovered late because of the low sensation in the user's hands. This increases the risk of

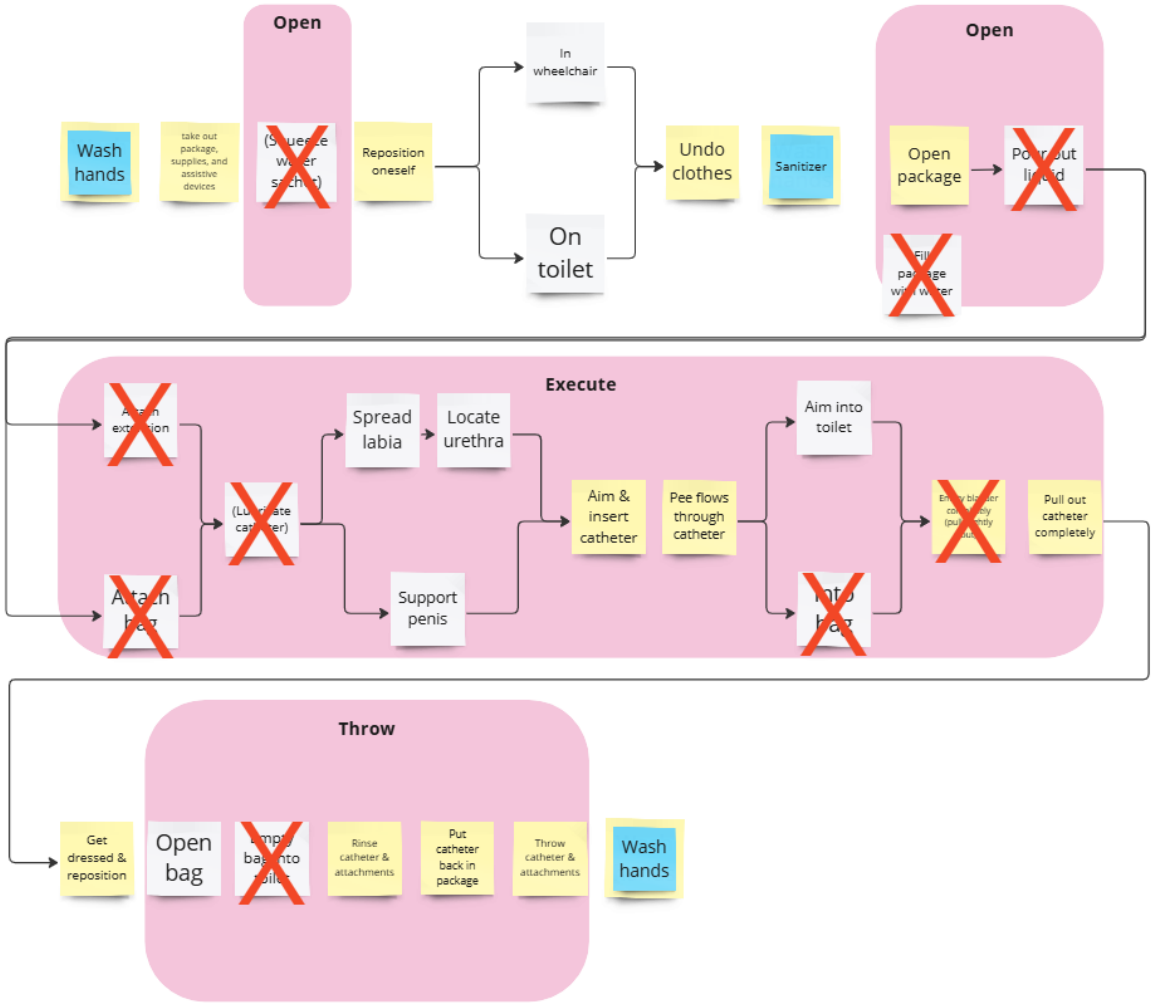


Figure 17. The whole bathroom visit was analysed and a portion of it (circled) was identified to be directly related to the catheter product. A second analysation looked at which actions are necessary to catheterise, and which actions are undesirable and have potential to be removed by design.

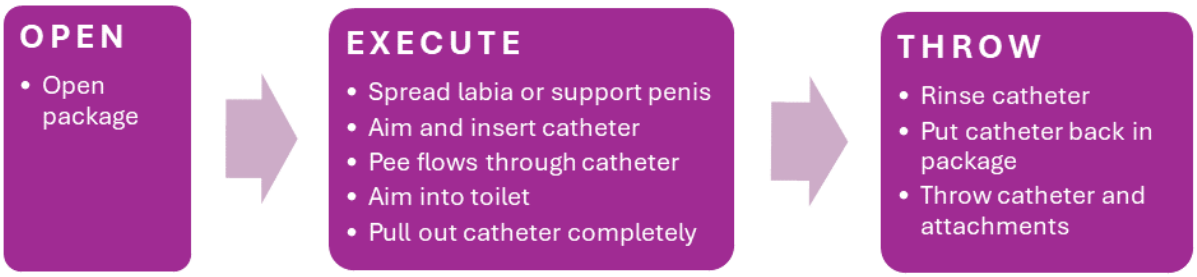


Figure 16. A suggestion for a desired user journey.

injuring oneself. Lastly, as the catheter is pulled out there is a high risk of spillage.

Stage Throw includes reinserting catheter into package and putting the catheter in the trash (neatly). However, many users do not spend the extra minute to throw the catheter neatly, but the reason is unknown.

4.6.1 A Desired User Journey

After analysing today's user journey, an optimised user journey is suggested in figure 17. Users want to self-catheterise easily and quickly, and that the whole process should happen spontaneously and intuitively.
Overall, the study participants want a more efficient process with fewer objects, such as assistive devices, added to the process. Expert E1 would prefer that the catheter contained everything needed to self-catheterise, so that the user would not need to add additional elements to the process. Fewer elements would lower the cognitive demand of the user, thus decreasing the risk of negative emotions when self-catheterising. Below are a few points of how the user journey can be improved.

"Nothing we humans should spend a lot of time on. You want to get it done."
- User U1

" Simple, fast, no fuss, few steps, intuitive. Just open and go to the bathroom "
- Wellspect Employee W4

Below are suggestions for how the user journey can be improved within the three different stages.

Stage Open

- Make it easy to open without hassle
- Use pre-wet or pre-lubricated solutions to avoid making the user to manually lubricate the catheter.

"I want an easy-to-open package. It would have been optimal if there had been a grip like this on the green piece [connector]. And then if there was an extension tube connected [pre-connected]. "
- User U5

Stage Execute

- Remove the barrier that's created by needing to attach a tube or bag.
- Make it easier to hold, aim, and insert without the need for an assistive device.
- Make it more noticeable if the catheter gets stuck.

Stage Throw

- Putting back catheter and making the waste more discreet should be low effort.

4.7 Take Aways from User Research

As the study continues into Phase Two, a concept will be developed based on the insights about the user experience. Users have been categorized into three different user groups: missed potential, independent users, and assisted users and the latter is chosen to guide the concept development. The intention is to improve the user experience of assisted users by adjusting the user journey according to their needs and while striving to achieve the articulated user experience goals. Achieving the UX goals about enhancing independence in activities of daily life and preserving the user's privacy through product discretion will increase the chance of the design proposal providing product benefits which are highly valued by the user.

4.7.1 Identified User Groups

The identified user groups were made according to their independence level throughout the user journey.

1. **Group "Missed Potential"** represented users who have sufficient hand function to self-catheterise but lack access to the urethra. Barriers for easy access could be for instance poor balance, body size, and intense leg spasms.
2. **Group "Independent Users"** self-catheterise by themselves and have developed techniques to handle the catheter product and necessary accessories. However, they still experience difficulties which prolong the time in the bathroom.
3. **Group "Assisted Users"** can independently insert the catheter into the urethra but need help with one or several steps in the user journey: opening package, putting on assistive devices, attaching urine bag or extension, or opening and emptying a urine bag.

The concept generation will focus on designing for the user group with the most barriers to self-catheterising. However, the barriers experienced by the group "Missed Potential" are so extensive that they may be too difficult to overcome in this study. In comparison, the group "Assisted Users" have barriers connected directly to the catheter products which can be altered through design. Therefore "Assisted Users" are chosen as the user group who could benefit the most from an improved user experience.

Considering the catheterisation skills among "Independent Users", it is anticipated that the final concept may benefit their catheterisation experience as well. The design choices made for the "Assisted Users" may result in design solutions which facilitates self-catheterisation for other users with low hand function.

4.7.2 Improve the User Journey by Making it Shorter

Users and experts alike have expressed that the self-catheterisation process is tedious and contains many elements which can cause worry. For the *assisted* user group, many of the steps in the user journey are not available to them because the catheter product's (or urine bag's or extension tube's) design is not adjusted for their low hand function.

The desired user journey should be short and contain the most necessary steps to self-catheterise. If possible, no extra objects should be added to be able to handle the catheter product.

4.7.3 Two User Experience Goals

The design choices made for the concept will highly depend on all the composed product benefits. However, the ideo-pleasures

independence and *protecting privacy* are the most important to achieve the UX goals mentioned below. They are strongly related to many other desired product pleasures which affect appearance, ease-of-use, ergonomics, etc.

UX Goal One: Enhance the experience of independence in ADL and throughout the user journey.

The design proposal should increase the user's sense of independence throughout the user journey of self-catheterisation which ultimately will have a domino effect on the user's independence during ADL.

UX Goal Two: Preserve the user's privacy by addressing aspects of product discretion before, during, and after the user journey.

The design proposal should not attract unwanted attention and not give away its intended purpose (through its appearance). It should also not look or feel like a medical product. This sense of discretion should be felt while storing the product, during self-catheterisation, and even when it is lying in a trashbin where it is visible for other bathroom visitors.

5 Phase Two: Methods and Execution for Concept Generation and Evaluation

The second phase of the study focused on concept generation and evaluation. Although the paper may present the results in a linear manner, the process of the second phase happened in three iterations before the final concept was finished (see fig. 18). Each iteration presented new learnings which lead to adjustments to the concepts.

As the idea generation started, it was desirable to create multiple ideas, both realistic and unrealistic, to nurture creativity and increase the chance of finding an innovative solution. For this, creating ideas without hindrance was done by using brain drawing and prototyping. This allowed the researcher to visualise ideas and explore them physically. Integrating a more critical idea generation method, Occam's razor, allowed the researcher to create more realistic ideas. All the ideas were categorised based on common themes between them.

Feedback sessions were held with Wellspect employees and user U4 who both previously partook the data collection (see chapter 4.1). Their feedback would aid in choosing which idea category to pursue, validate and criticise the ideas, and initiate new iterations of the concept development. The final concept was evaluated by expert E1 by comparing today's user experience to the final concept's user experience.

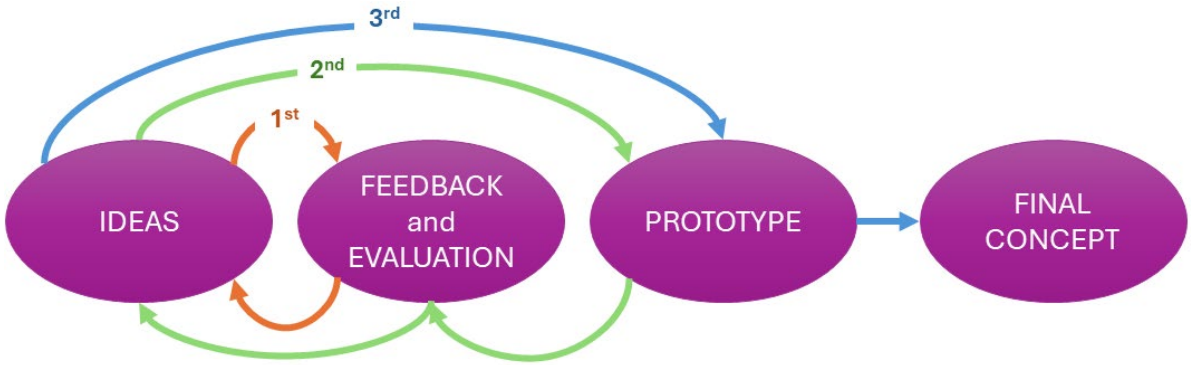


Figure 18. The process of the study's second phase happened in three iterations.

5.1 Brain Drawing to Generate Multiple Ideas

The brain drawing method is a tool to generate ideas by drawing. It was chosen to initiate the idea generation phase to stimulate creativity and not worry about the quality of the ideas. This method encourages to produce bizarre ideas and therefore it is not allowed to criticize anyone's ideas. (Wikberg-Nilsson et al., 2015). The purpose of choosing such a method is to create a multitude of solutions to solve the issue(s) and avoid spending too many resources on just one solution without exploring other (potentially better) options.

By using brain drawing, the researcher was able to generate ideas that had been brewing throughout the data collection phase without holding back. Initially, the researcher had neither prompts nor a time limitation when drawing on A3-sized papers. Any thoughts or ideas that came to mind were drawn or written down on the same paper until it was filled, before grabbing a new sheet. Once the ideas slowed down, prompts were introduced to reignite creativity. The prompts were related to the collected data: "handling connector", "handling and hiding extension tube", "cut out steps in the user journey", "minimizing tissue damage through appropriate user feedback", and "packaging". Inspiration was derived from everyday products such as water bottles, sewing machine equipment, cord cable organizers, and baby chew toys to name a few.

5.2 Exploring and Assessing Features with Occam's Razor

Occam's razor is a method based on a reasoning principle in philosophy about not adding unnecessary assumptions to an argument (Braithwaite, 2007). In design, it is used to explore ideas and evaluate alternatives to avoid choosing unnecessarily complex designs. A design's effectiveness is lowered when the user needs to understand unnecessary elements which makes the design less intuitive (Wikberg-Nilsson et al., 2015).

Occam's razor helped to understand which features may be unnecessary for the user. The researcher assessed parts of the user journey (activating, opening, attaching, and inserting) in relation to existing catheter products. The prompt "What are the absolutely necessary features for a user to self-catheterise properly?" functioned as a guide during the assessment. Ideas and thoughts were sketched and written on paper without any time limit.

5.3 Prototyping to Ignite Creativity and Facilitate Communication

Prototyping was used as a tool to express ideas, explore features, and to communicate with study participants throughout the concept development process.

This study used the **quick and dirty prototyping** to investigate sketched ideas from brain drawing from a 3-D perspective. Quick and dirty prototyping is a haptic tool to stimulate creativity. It provides an additional dimension to expressing, exploring, and communicating ideas (Gómez & Lopez-Lean, 2019). The researcher investigated size, functionality, and ergonomics by quickly shaping the sketched ideas into prototypes using modelling clay, tape, random objects, and chenille stems allowed. The ability to physically experience ideas from all angles triggered new ideas.

Functional prototypes are used to show a product concept's core features and capabilities (Ulrich & Eppinger, 2016). The

purpose of using functional prototypes for this study was to explore size dimensions and features of the concept.

The concept included a package made of plastic film. To gauge suitable plastic films for the prototypes, the researcher explored the material library at Wellspect by rubbing different plastic films between their fingers to assess the friction, thickness, and the noise they produced. The desired experience was to have a package that did not make too much noise and attract unwanted attention. Secondly, the package could provide some friction to secure the user's grip while catheterising.

Three functional prototypes of varying quality were made to explore grips, shape, and size. Tools and materials that were used were: thermo sealing plastic films, impulse sealers, handheld sealers, iron machine, tapes, and modelling clay. For one feature, CAD-modelling and 3D-printing was used.

5.3.1 A Test to Understand the Concept's Behaviour when Urine Flows Through

Predictable behaviour of the catheter products was an identified user need. For example, the catheter tube should not be wobbly because it becomes difficult to insert into urethra. Another example is that the user should be able to rely on the extension tube staying steady in the toilet while urine flows through, so they do not end up with urine on the floor. The concept concerned reusing the catheter package as an extension tube and therefore it was important to understand how the packaging would behave when urine flows through it.

Therefore, a test was conducted on four tubes of different stiffness, 3*40 cm, that would represent packages being converted into extension tubes. Three tubes were self-made out of plastic films from the material library. The fourth tube was a premade aluminium packaging from a catheter manufacturer.

The test looked at the tubes' behaviour when 200 ml water was pushed through the tube with a syringe and into a sink while holding the tube with one hand. The tube was not resting against anything, but rather held in the air. The test was done in two rounds. The second test started after the tubes were folded for 24 hours. This would give an indication on how material memory may affect the tubes' behaviour. The whole test was video recorded to analyse the tubes' behaviour after the test.

5.4 Video Recordings to Communicate Concept

Two video recordings (see fig. 19) of two functional prototypes were used to communicate the concept's core features and capabilities during feedback sessions.

The first video (video #1) was shot in one take with a neutral background without any audio. Slow hand movements combined with pointing was used to demonstrate how to open the prototype, execute catheterisation, and throw the prototype. It was noticed when the participant viewed the video, that it was not descriptive enough to communicate how to use the functional prototype. Therefore, the researcher made additional comments as the video was playing.

The second video (video #2) was shot using two different settings: one with a neutral background and one with a toilet. Since the first video did not feel descriptive enough, descriptive text was added throughout the second video to say what type of catheter it is and instructions to use the prototype. Other than that, this video also used slow hand movements, pointing, and no audio.

Figure 19. Both prototype videos were shot with the same background. Video #2 contained descriptive text to make the video easier to understand without the need for extra commentary.

5.5 Feedback and Evaluation of Concept

Gathering feedback and evaluating concepts is useful to identify how well the concept is fulfilling the user's needs and prerequisites. It can also help to find usability issues.

For this study, feedback sessions were used to evaluate the design of the concept and see which features need improvement. Three feedback sessions were held, where the last session contained an evaluation task where the concept's user journey was compared to today's user journey.

The first session focused on evaluating the multiple ideas and concept categories which had been generated from brain drawing, Occam's razor, and quick and dirty prototyping. Two Wellspect supervisors participated to provide insight in how feasible the different categories were. In other words, how easy it would be to start manufacturing a product in regard to how much extra research and development needs to be done.

The second session was a digital meeting together with user 4 who provided feedback on the 2nd generation prototype after viewing video #1 and learning about the take aways from phase one of the study. Their feedback initiated another iteration.

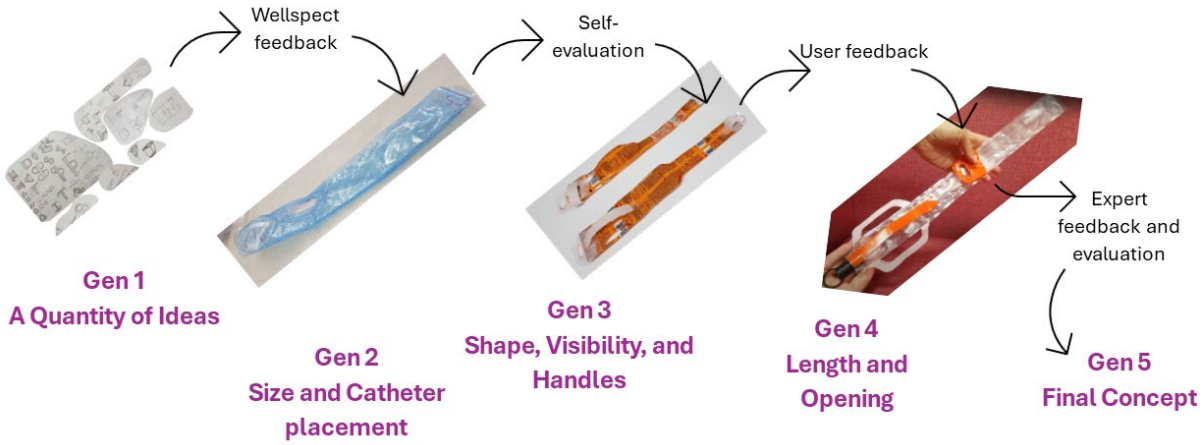
The third and last session was a digital meeting with an expert (E1) who works as a urologist. To start off the meeting, the researcher presented the outcome from data collection and proceeded to ask the expert to fill in a user journey about how well the users can self-catheterise today from their professional perspective. Afterward, they were shown video #2 before filling in the user journey again, but now with their assumptions about how the concept would affect the self-catheterisation.

5.6 Process of Developing the Final Concept

When creating and analysing the design, the user journey's three stages *open*, *execute*, and *throw* were taken into account. Features for each stage were explored to see if and how they would facilitate the self-catheterisation experience. Multi-purpose features were designed to be useful for two or all three stages. Not having too many features is beneficial for the user as it lowers the risk of the design's interface looking too complex which would lower its ease-of-use, especially for beginners at self-catheterisation.

The aim for the design was to improve the user's sense of control, lower the cognitive demand, provide a sense of discreetness, and general interaction with the catheter throughout the user journey.

Figure 20. The process contained five generations of concept development where each generation focused on different design features.



6 Phase Two: Result of Concept Development

The idea generation served to find a direction for concept development and explore the ideas which had been brewing subconsciously throughout the data collection. It resulted in three idea categories:

- Easy attachment of a separate extension tube
- Package or connector converts into extension tube
- Subfeatures

At the end, the idea categories were presented to Wellspect employees who shared their thoughts on feasibility regarding resources, time to market, and how well they complemented the existing product line.

6.1 Idea Category "Easy Attachment"

The topic of this category is to facilitate attaching and detaching an extension tube by eradicating the need for a pincer grip. A few idea varieties emerged while sketching.

The first concept variety imitates the original push and pull motion which involves pushing the extension's connector (which is the piece of the extension tube that is inserted into the catheter) into the catheter connector to attach it and pulling it out to detach. The existing connector designs in today's products do not allow the user to have a secure hand grip and apply a counterforce at the same time. The connector on both the catheter and extension tube is therefore redesigned to support the push-and-pull mechanism to ensure ease of use and reliability. The sketches shown in figures 21 to 24 demonstrate designs that can enable "finger hooking" and mouth grips. To maintain the familiar push-and-pull mechanism in existing systems, the connectors need to be redesigned. This alteration is crucial for compatibility and user familiarity.

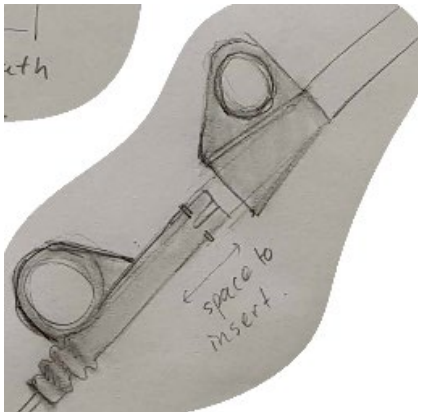


Figure 23. Holes to hook fingers into both connector and extension.

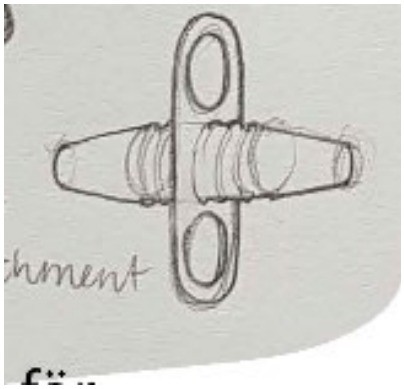


Figure 22. A connector which attaches to the extension and remains there until switching to a new and clean extension tube.

Figure 21. Catheter connector with finger handles placed on the sides. A bite friendly loop is placed in the middle.

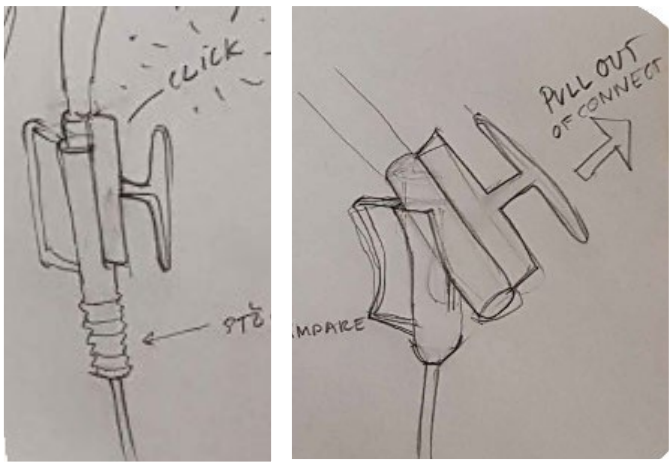


Figure 24. The catheter connector has a handle to hook fingers and the extension tube connector allows to combine hooking fingers with a pencil grip. The extension is slid into place and then easily pulled apart from the catheter out of a pre-made slit in the catheter connector.

The second concept variety (see fig. 25) is a reusable device that the user connects to the extension tube prior to catheterisation. Once it is time to catheterise, the catheter connector is slid into a track on the device. The track assists the user to guide the connector into place without the need for finger strength. It also becomes less cognitively demanding compared to aiming the extension tube into the catheter connector.

Once secured, the device provides an audible "click" feedback to inform the user that the catheter is properly connected. The feedback is designed to fulfil the preferred need of audio feedback over haptic because of the user's low sensation in their hands. After catheterisation, a button is pushed to release the catheter. The button should *not* be designed to rely on the user isolating one finger to push it, but rather enable the user to push the button with other parts of their hand or against an object, for example the edge of a sink or the armrest on a wheelchair. The device is transferred to a new extension tube whenever the user needs to switch the extension. This solution could potentially include handles to secure the grip during catheterisation.

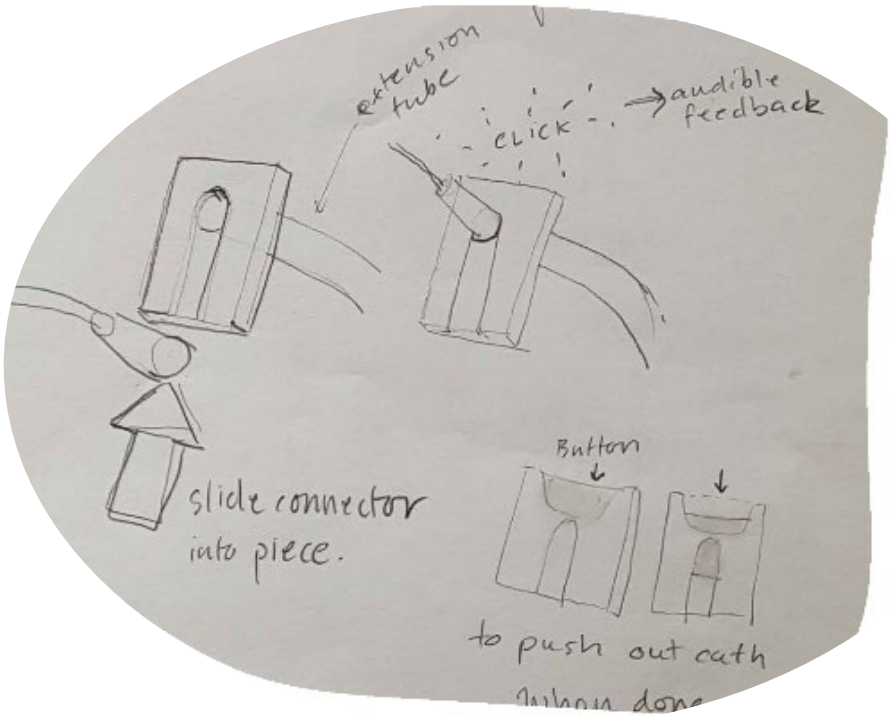


Figure 25. The user can slide the connector into place with this piece which is fastened to the extension tube prior to catheterisation.

This concept is meant to stay on the extension tube for a few days before switching it out, meaning that it only needs to be tended to once or twice a week. It allows the user to use a reusable extension tube of their preference and to attach (and detach) it to the catheter tube without a pincer grip. Even though it is a separate object, the low amount of attention it requires may decrease the feeling of it being "yet another assistive device". And considering the user journey, this solution does not add an extra step to the catheterisation process since the device is pre-installed prior to the bathroom visit.

6.2 Idea Category "Package or Connector Converts into Extension Tube"

These ideas intend to shorten the user journey by eradicating the steps *attaching* and *detaching the extension tube*. The ideas integrate an extension tube in either the catheter's connector or packaging. Doing so lowers the user's cognitive efforts taking care of and catheterising with a separate extension tube.

The first concept variety is that the package converts into an extension tube after the catheter has been pulled out. During idea generation, different shapes and sizes were explored. For example, a circle shaped package was made of a flimsy plastic film. The user would break the circle when opening the package and pull out the catheter tube from the inside of the circle. The other end of the circle would be attached to the catheter and act as the extension tube. A second example was explored by using wide drink straws to make a zigzag-shaped package. It could be stretched out to create a longer package which is useful when using it as an extension tube to improve reach to the toilet or shortened which can help the user store it discreetly in a bag. The design suggestion shown in figure 26 is cone shaped and is opened from the "bottom". As the package opens, the user automatically pulls out the catheter and pulls until the catheter gets stuck. The package can then be used as an extension tube.

The second concept variety (fig. 27) is a redesigned catheter connector where the extension tube lies inside it. The user pulls out the extension by hooking their finger into the

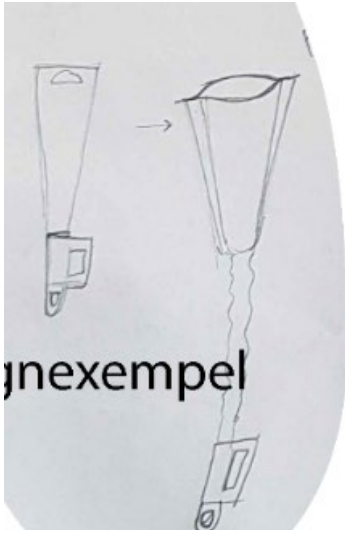


Figure 26. A sketch of a catheter pulled out of the package and the package used as an extension tube.

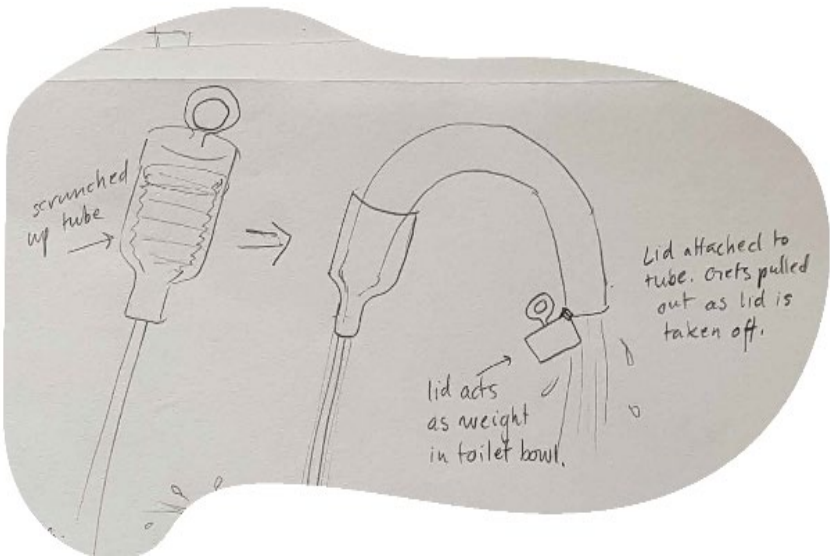


Figure 27. The catheter connector containing an extension tube pulled out by hooking a finger into the lid.

lid and pulling, and therefore does not need a pincer grip. The lid stays attached to the extension and acts as a weight to keep the extension hanging over the toilet seat while catheterising. The weight can potentially create a more predictable extension tube by ensuring that it stays in place when urine flows through, and thus provide a benefit of a *worry-free* catheterisation.

A benefit of these concept varieties is that the user does not need to carry a separate extension tube since it is included with the catheter. Both concepts have the potential to incorporate features to secure the grip while catheterising and improve overall control of the product throughout the user journey. From the *assisted user's* perspective, these concepts can provide pleasure as they remove a physical barrier to a more independent self-catheterisation.

6.3 Idea Category: Subfeatures

As the brain drawing and quick and dirty prototyping progressed, concepts for subfeatures emerged to answer several issues found in the analysis: damaging the urethra, the extension tube moving while urine comes through, and manipulating the product. This resulted in three types of subfeature categories:

- Manipulate products with finger loops and bite surfaces
- Information through visual feedback and avoiding tactile feedback
- Lowering cognitive demand by keeping extension tube in place

Manipulate Products with Finger Loops and Bite Surfaces

To improve the user's control of the product, they need to properly be able to grasp and manipulate it. This means that the user should not be required to use grip or finger strength to interact with the product and that the product should be adapted to tetraplegic hand grips.

Loops were explored to see how different sizes and placements would affect the user's grip. The loops-idea was inspired by the existing solution of attaching keyrings to more easily manipulate objects by getting a better grip. The explored designs looked at the ability to hook one or several fingers, using the pencil grip, using teeth to bite, and using either left or right hand. Loops are versatile and can be added at any point in the user journey to facilitate controlling the product.

Biting surfaces can be added when the user needs to apply extra force. These surfaces need to be comfortable to bite on and soft enough to not damage the teeth. A softer "squishier" material, like baby teething toys, can communicate that it is a surface appropriate for a mouth grip. In figure 28, different placements and shapes were explored. The surface could be created purely for biting or combined with a loop. A biting surface combined with a loop could provide a physiological and psychological pleasure. The user could choose to adjust their grip from their hands to their mouth if they feel the need for extra strength. As the grip is already made for biting, they would not need to feel worried about not getting a good bite-grip and accidentally damaging their teeth.

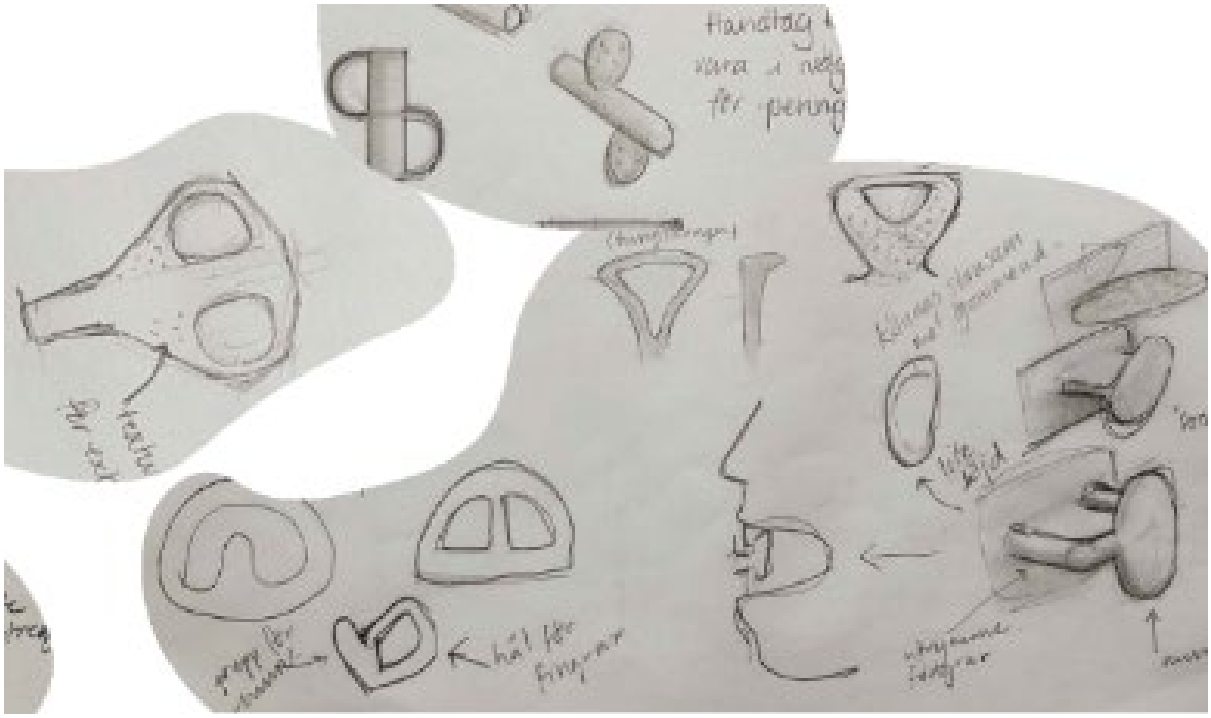


Figure 28. Ideas for shapes and placements of biting surfaces.

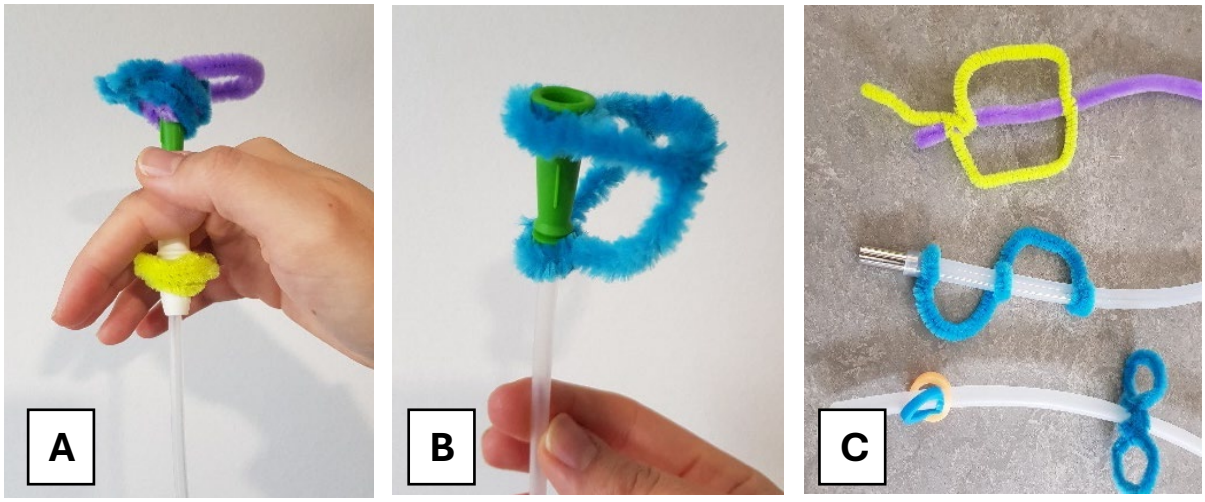


Figure 29. Quick and dirty prototypes of catheters and extension tubes.

In figure 29, picture A illustrates a catheter connector prototype with a loop to hook a finger in purple, a surface to bite in blue. The biting surface can help the user to apply extra force when attaching or detaching an extension tube or urine bag. A "stop" in yellow is placed at the bottom of the connector to stop the catheter from sliding out between the fingers when the user applies a push-and-pull motion while catheterising.

Picture B shows a catheter connector prototype that has several loops. Because of the varieties in grip preferences among users, they can choose to insert their finger from either the top, bottom, or side. It allows the user to choose which loop is most comfortable and would create the best angle for their arm and/or wrist when self-catheterising.

In picture C, different loop placements on extension tubes were explored. Each prototype offers two grips on each side of the tube and provides two-hand grips. This would fulfil the need of creating a stable grip for users

who need two hands to catheterise. Once the catheter is attached, the user can use these extra handles to insert their hands or fingers.

illustrates other loops which also are useful for self-catheterising and attaching to a catheter

Information Through Visual Feedback and Avoiding Tactile Feedback

As previously mentioned, audio feedback can be used instead of tactile. This subfeature however (fig. 30), intends to provide visual feedback whenever the catheter gets stuck, either on the way in or out. The suggested design alters the catheter connector to create a visible "shock absorber", which compresses when the catheter is pushed against the urethra channel or the bladder wall and extends when the catheter is stuck when pulling it out of the urethra.

The user will gain better control of the process and can more quickly make decisions whether to paus or restart the self-catheterisation. It is because the visual feedback provides information about how well the process is performed which may lower the user's cognitive load as they do not need to guess whether the catheter tube is moving smoothly through urethra or damaging it.

This feature is mostly useful for male users, or users with a mitrofanoff because they can easily see the connector while catheterising.

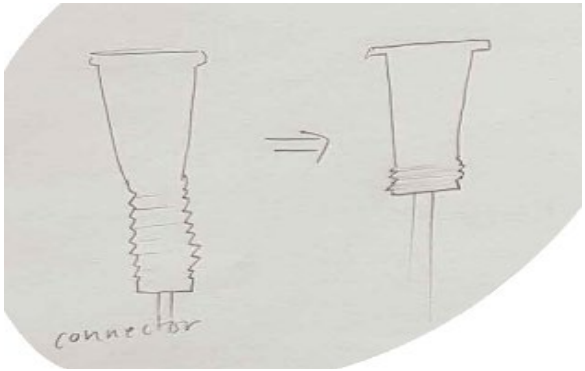


Figure 30. Shock absorber providing visual feedback as the user can see it compressing.

Female users on the other hand, cannot see the connector easily and will not the same control of the catheterisation process. But they can still benefit from the shock absorption feature to minimise damage.

Lowering Cognitive Demand by Keeping Extension Tube in Place

These conceptual subfeatures keep the extension tube in place when urine starts flowing. The extension can be attached by using a hook on the toilet seat, or a sticky surface to stick it on the seat. It can also be weighted and act as an anchor in the toilet bowl, without touching the water.

Users experience a worry that urine will spill or splash onto them when urine starts flowing through the extension tube. The extension can start "acting like a snake" where it moves around unpredictably unless it is held in place by holding it with a hand or putting it under the toilet seat. Occupational therapists recommend users to put it under the toilet seat, which also makes a hand available to insert the catheter. Needing to position and insert the catheter at the same time increases the cognitive demand.

6.4 Feedback from Wellspect R&D-Employees

The feedback regarding feasibility varied between the concepts. First, the concepts from the idea category *package or connector converts into extension tube* were perceived as likely to require a substantial amount of research and development resources in comparison to the other presented concepts before it would reach the market.

The first concept from the idea category *easy attachment* was perceived as difficult to do. There is already a standard connector which is used across all Wellspect products and changing the connector would cause

consequences across all catheters and packaging. A larger shaped catheter may not fit into today's packages, and the increased material usage may collide with their environmental sustainability goals.

The *easy attachment* slide-and-click concept (second concept variety) could be designed to become compatible with all Wellspect urinary catheters. Since it is reusable, there would more freedom to make the design "bulkier" by adding larger features. A design with larger features is potentially easier to handle compared to small features.

6.5 Idea Selection for Concept Development

Based on user research and evaluation, the chosen concept to continue to develop for the final concept was the *integrated extension tube in a package*. Although this concept was deemed to be a more resource demanding product if it were to be further developed by the company, it shows the potential to improve the user experience for both assisted and independent users before, during, and after the user journey.

By integrating the extension tube together with the catheter, the need to attach the extension tube manually is removed. This step was noted in the user research to be extra challenging to execute. The chosen concept also provides other benefits, for example, the user will always have access to a clean and ready-to-use extension tube. Today's solution is to carry a catheter, an extension tube, and an assistive grip device separately wherever the user goes, but with this concept the catheter product provides an all-in-one solution with fewer loose objects. It will provide the pleasure of spending less time in the bathroom because the user will have less objects to keep track of and clean. This will be especially useful in public settings which tend to cause stress. These benefits may offer a more pleasant catheterisation when the user must empty their bladder in a stressful situation.

Throughout the idea generation, packaging shapes such as a circle, a zigzag-shape, and rectangles were explored. The circle and zigzag-shape created challenges when pulling out the catheter from the package, e.g. getting stuck in the package or the catheter tube becoming zigzag-shaped which would make insertion quite difficult. As a result, out of the different packaging shapes, the classic, long and straight package was chosen to be the initial starting point for concept development.

6.6 Development and Evaluation of the Final Concept

In this chapter, the evolution of the final concept is explained by following the user journey's three stages *open, execute*, and *throw*. Different features were explored and compared to each other to analyse how they may affect the design's ease-of-use, and which benefits they may provide the user. An evaluation with the urologist provided insights into positive and negative aspects about the design.

The concept development and evaluation resulted in a sketch of the final concept which is presented together with its features and usage instructions. At the end of this chapter, design guidelines are formulated to aid in future design projects when designing catheter products for tetraplegics with low hand function.

6.6.1 Developing *Stage Open*

Stage open is about opening the package, accessing and lubricating or activating the catheter. Based on user research, the users wanted to quickly be able to empty their bladder and would experience displeasure when *stage open* would take too long. For example, they would experience autonomic dysreflexia symptoms, increasing frustration, and become stressed.

While developing the conceptual design's features, the focus was to improve the user's control of the design's opening mechanisms and instantly get access to a ready-to-use catheter.

Assessing Lubrication Methods

By assessing today's available lubrication and activation methods (see p. 5) based on the user journey, it was understood that pre-activated and pre-lubricated catheters provide the benefit of a quicker access to a catheter that is ready to use. The user will have the pleasure of more quickly being able to empty their bladder and relieve themselves from any discomfort and feel more relaxed.

If the user were to manually lubricate or activate dry catheters, they would need to handle additional steps in the user journey. These steps add to the time spent in the bathroom which can cause displeasure for the user when they are in a stressful situation.

The conceptual design would fit more seamlessly in Wellspect's existing product line if it were a pre-wet hydrophilic catheter since hydrophilic catheters are their speciality.

Opening the Package

The rectangular package must be opened on both short ends so it can be converted into a tube where urine flows through. By drawing inspiration from the idea generation's "finger loops" and today's existing solution of finger-sized holes in the packaging, ways of opening the package was explored. The initial point of exploration started by cutting out finger-sized holes at the short ends of the package. During this exploration, two issues emerged.

The first issue occurred when the films were to be pulled apart from each other to break open the package. The user must be able to easily use both hands when pulling apart the films, e.g. one hand per film. To put it another way, whenever the user needs to apply a directional force, e.g. a push or pull motion, they need to be offered a "counter grip" so they can properly hold the object in place when applying that force. If the user only can grip one film, they would need to find another way to get a hold of the other film, e.g. use their mouth or ask for assistance. The latter would decrease their independence while catheterising.

The second issue was that the plastic films tend to stick together and were difficult to separate without the use of a pincer grip. This behaviour made it difficult to easily access the finger holes. Not being able to easily open the package can evoke negative feelings and induce stress, especially when the user is in a hurry.

To further investigate how to get around these issues, straps were explored to see how they could improve the user's control of the design. These straps could help the user to effortlessly get a hold of the plastic film and pull open the package.

Exploring Vertical and Horizontal Straps to Improve Control

Applying grip straps horizontally and vertically was designed to explore how they could affect the opening the package (fig. 33). One prototype has the straps placed horizontally on each end of the package while the other prototype has the straps placed vertically on each end.

The horizontal strap A at the top end of the package allowed both wrists be angled similarly to each other as opposed to the vertical strap. The vertical strap B forced the hand to apply a different angle on one wrist compared to the other. The vertical strap C at the bottom end of the package appeared to be functional for both opening the package and acting as a handle to use when self-catheterising.

The strap feature is assumed to fulfil the need of comfortably and efficiently opening the package without the need to use the mouth. The vertical strap's versatility opens yet another grip option for the user to use when self-catheterising and handling the extension tube.

Converting the Package into an Extension Tube

After the user has opened the package, it should automatically convert into an extension tube once they pull out the catheter. This only seemed to be possible if the catheter was pulled out by the tip, as opposed to the connector which is considered the standard way of taking out the catheter. From a feedback session, user U4 suggested that the two steps of opening the package and pulling out the catheter can be merged into one action, thus improving the efficiency of the overall user journey.

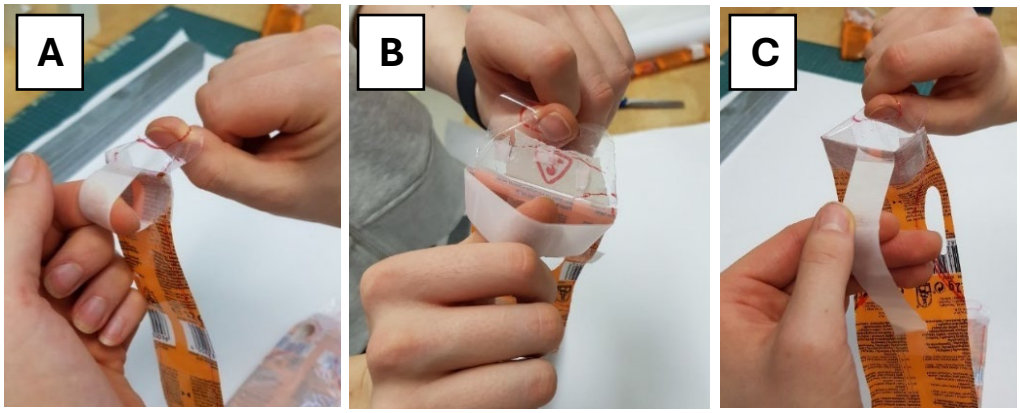


Figure 31. Prototypes with vertical and horizontal straps made from office tape.

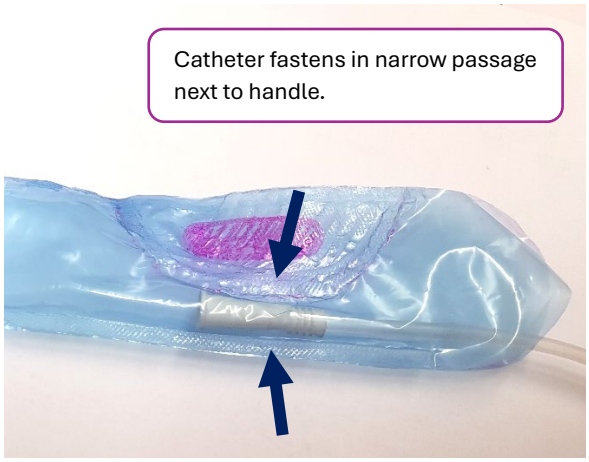


Figure 32. Catheter pulled down and fastens next to the handle.

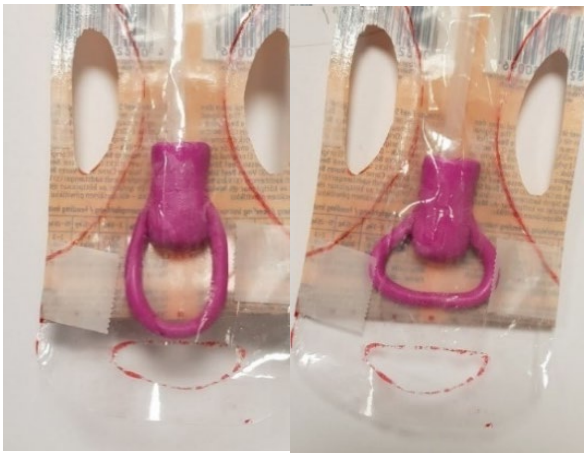


Figure 33. The shape of the finger hook was explored by using modelling clay to see which would be an easier shape to insert a finger and feel comfortable when pulling. The model to the left allowed more space for the finger to be inserted.

During the development of *converting the package into an extension tube*, two issues became apparent. One issue is that the user can accidentally pull out the catheter too far. To avoid this, the catheter connector needs to somehow attach to the bottom end of the package once it has been pulled out all the way. Two alternatives to attach the connector were tested. The first alternative was to shape the package plastic film and make the passage too narrow for the connector to pass through (see fig. 32). The second was to add a hard plastic funnel for the connector get attached to.

A second issue is that the user should not touch the catheter tube when pulling the catheter out of the package as it increases the risk for complications, such as UTIs. To circumvent this problem, a lid placed on top of the catheter tip explored.

Pulling Out the Catheter by a Lid

Clay prototypes were placed on the tip of the catheter to try different shapes and sizes (see fig. 33). The lid should enable the user to hook their finger and pull out the catheter fully before detaching. To access the catheter, the user pulls out the catheter until the connector gets stuck. Once the connector is attached to the bottom of the package, the lid is further pulled to pop off the catheter.

Exactly how the lid technically holds on to the catheter is not decided, but it was inspired by existing catheter products with a similar feature. This suggested solution is nonetheless a quick way for the user to get a hold of the catheter and pull it out without touching it.

6.6.2 Developing Stage Execute

To self-catheterise successfully the user should be able to easily insert the catheter, control the direction of the urine stream and understand when to move the catheter inside the urethra and bladder. Therefore, evolving the conceptual design's features for *stage execute* involved looking at the package's length, adjustability for different users' grip preferences, exploring transparency for visual feedback, and understanding how plastic film thickness can affect the extension tube's reliability when urine flows through.

Length Affecting Ease of Use and Discretion

Different package lengths were investigated to see how it would affect ease of use and discretion. Commercially available extension tubes come in 35 to 70 cm.

The first packaging prototypes were 35-40 cm. The catheter could not lie straight in these packages and therefore had to be folded or rolled up to fit (see B in fig. 36). The top portion of the package could be folded to make the product smaller for storage in, for example, a bag. However, the bundled-up catheter creates a wobbly catheter tube which makes it more difficult to insert into urethra.

After feedback from user U4 and Wellspect supervisors, it was noted that the users need an extension tube around 60-70 cm, so they don't need to hold the extension into the toilet while catheterising. So, a long 70 cm prototype was made (see A in fig. 36). With 70 cm, the catheter could lie straight, and the extension tube could hang over the toilet seat while the user self-catheterises. The user can put their cognitive efforts into aiming the catheter into urethra and not worry about holding the extension tube to keep it in place. This is especially useful for users who prefer a two-hand grip around the connector when self-catheterising. However, a benefit with a smaller package is that it can feel more discreet, so the top was folded over. The top 20 cm of the package could be delivered to the user folded down and attached with a sticky tab to take up less physical and visual space.

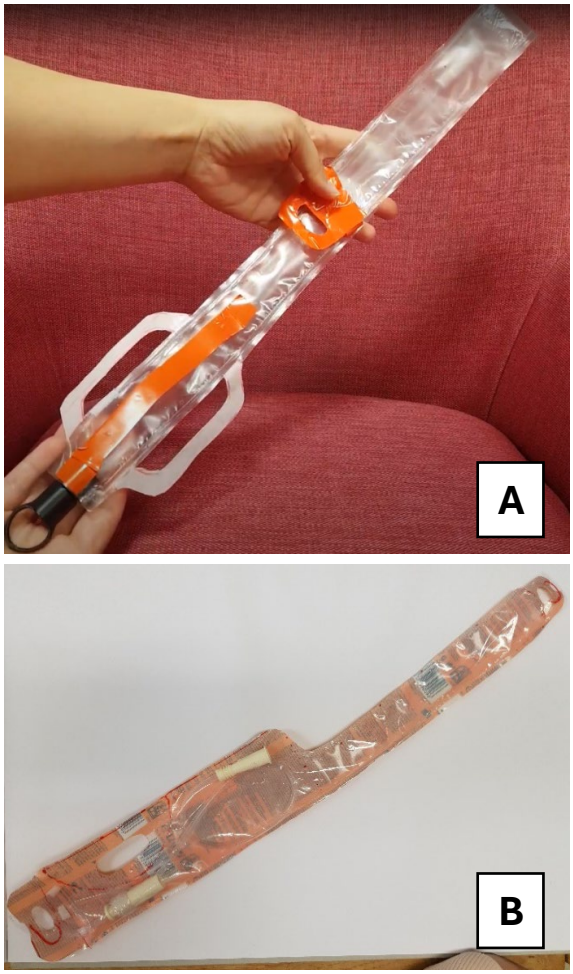


Figure 34. A 70 cm long package (top) where the top extending over the catheter is folded down to give the product a shorter appearance and take less space. A 40 cm long package (bottom) requires the catheter to be folded to fit inside.

Figure 35. A multipurpose sticky tab (circled) which keeps the package folded and can be used to secure the extension tube to the toilet.

Multipurpose Sticky Tab to Keep the Extension in Place

The user needs to be able to rely on the extension tube staying in place and not moving when urine flows through it. Otherwise, users will constantly worry about urine spilling onto the floor or on their clothes. Therefore, ways to secure the extension tube to the toilet was investigated. In the idea generation, weights and hooks were potential design solutions. However, during the progression of the conceptual packaging design, it was seen that the top portion of the 70 cm packaging could be folded down and attached with a sticky tab. From the feedback session with user U4, a suggestion was to reuse the sticky tab to attach the extension tube to the toilet seat (see fig. 37).

A Reliable Grip for Different Grip Preferences

Placing handles at the bottom of the package, where the extension begins, may lower the need for using an assistive grip device to hold the catheter when catheterising. The product then assists with both extending and holding the catheter. This handle feature removes elements connected to using an assistive grip device from the user journey, thus increasing the potential for a more effective and efficient bathroom visit.

Packaging shapes, a symmetrical and an asymmetrical, were explored to see how it would affect handle placement (see fig. 38). A symmetrical shape opened the possibility to create handles on each side of the package. Having two handles allows a wider range of possible grips for the user, for example they can use both hands to hold the product and potentially position and guide the catheter into urethra more easily.

An asymmetric shape fits only a handle on one side and therefore dictates which hand the user should use. If it is placed on the left, then

it is easier to use for users who prefer using their left hand, and vice versa. To reach a wider audience, the symmetrical shape would be more beneficial since it is more flexible toward different grip preferences. Users can more easily interact with the product and have control over it.

Visual Feedback to Increase Control

When inserting the catheter through urethra, the user looks after urine starting to flow as an indication to stop moving the catheter further in. A cue to start pulling out the catheter is when the urine stops flowing. This visual information helps the user to understand whether the bladder needs to be emptied further or not.

A transparent extension tube is useful to provide this visual feedback of when urine is flowing through. Additionally, users can see the urine's colour which can indicate the quantity of their fluid intake, or if there are any wounds or illnesses in their urethra or bladder. However, because the extension is supposed to act as a packaging, a completely transparent packaging may be too revealing of the product's purpose.

To address this need of visual feedback and discretion issue, prototypes were made in different grades of transparency. Either they were completely transparent, or they had one side transparent (and the other side opaque). The latter does create an opportunity for the user to flip the package facing the transparent side downwards if they would want more discretion.

As a consequence of only having one side transparent, the product will have a "right side" facing up when catheterising. The user's grip should then accommodate keeping the transparent side upwards.

Ultimately, a fully transparent package is not ideal for discreetness, but strategically transparent surfaces lower the user's cognitive efforts to guess how the urine is flowing through the extension and could contribute to a positive psycho-pleasure.

Figure 36. Asymmetrical prototype (left) and a symmetrical prototype (right).

Table 12. Results from testing tubes made from different plastic films.

Tube	Test 1	Test 2 after being folded for 24 h
A	The tube folded from the weight of the water instantly.	The tube folded from the weight of the water instantly.
B	More rigid than "A" but it was noticeable that it started to fold from the weight from the 2nd 100 ml injection.	A bouncing behaviour occurred which disappeared once straightened.
C	For the 1st syringe, the tube seemed to be blocked because the plastic film layers were sticking together and caused a backflow. The water then pushed through the blockage in intervals, making the tube bop in intervals. However, during the 2nd time there was a free passage through the tube, and it showed to be sturdy.	A bouncing behaviour occurred which disappeared once straightened.
D	Very rigid and stayed straight. Did not change behaviour at all from the water's weight.	Stayed stable and did show any bouncing behaviour.

Extension Tube Behaviour when Water Flows Through

One aspect of the product's reliability is the structure of the package once it converts into an extension tube. The other aspect is how well the tube stays directed into the toilet during the self-catheterisation process. The structure of the extension tube was investigated by testing four different rectangular tubes made from materials sourced from Wellspect's material library. The tube sizes and shapes were made to be similar to the packaging prototypes, 3 cm wide and 40 cm long. The result can be seen in table 12.

Choosing the right material composition is outside of the study scope, but it is nonetheless interesting for the study to get an indication of how films of different thicknesses and stiffness may behave when liquid flows through the extension tube. Three of the test-tubes were made of plastic film and the fourth was an existing aluminium package from a catheter manufacturer. The descriptions of the tubes below are relative to each other.

- Tube A: Plastic film, least thick, flimsy
- Tube B: Plastic film, less thick, little less flimsy
- Tube C: Plastic film, thick, less flimsy
- Tube D: Aluminium, thick, least flimsy (easy to manipulate)

Folding the tubes for 24 hours did create indents in the tubes which caused them to point upward and/or downward instead of straight forward. The indentation increased the risk of the film sticking together and create a blockage and consequently caused the bouncing behaviour as the water was let through little by little. However, this behaviour disappeared in both tube B and tube C once the tube was straightened, and the indentation was smoothed out by squeezing

the indentation from the sides to open the barrier.

When observing tube D, it behaved very rigid and did not show any bouncing behaviour. Since it was so rigid, the risk of backflow was higher because the tube's indentation withstood the pressure from the water build up. Similarly to tube B and C, it needed to be straightened and squeezed to open the indentation.

In a real-life setting, manually adjusting the extension tube to ensure that the passage is not blocked adds an additional step to the user journey. It can cause the user worry whether the extension tube is straightened enough, if urine will bounce up and down the toilet, or worse, if there will be a backflow either onto the user or back into the bladder. Eventually the product will be perceived as too unreliable to use.

Conclusively, tube D had the best result because it did not bounce. However, the risk for backflow still exists. Regarding design choices for the concept, the user needs to be able to rely on the tube directing urine into the toilet directly, nowhere else, and without splash and spillage. It can be concluded that the material should enable an open passage through the tube without the user needing to manipulate it before or during the catheterisation.

6.6.3 Developing Stage Throw

Some users put back the catheter into the package before throwing it away; this is also considered the hygienic way of throwing a catheter. After catheterising the user could push the catheter back into the package.

The package could be kept folded together in the trash bin by reusing the sticky tab, which was suggested by a Wellspect supervisor. The user would not need to worry about it poking out of the trash once they have left the toilet.

6.7 Design Evaluation: A Urologist's Perspective

After showing an instructional video of the latest functional prototype, expert E1 provided both positive and negative feedback. They also evaluated the user journey of today's catheter products as well as their perspective on the user journey of the concept. The results were compared to each other.

Environmental sustainability is a criterion that is important to many users according to E1. It can affect their decision-making if they are choosing between similar products. If a product is perceived to have a lot of "bits and pieces", then it is viewed negatively from a sustainability standpoint. However, if the same product enables the user to self-catheterise independently then they will choose that product; independence will always stand above environmental sustainability among the users' values.

E1 talked about how packages have been used as extension tubes before, but that sometimes the packages' structures could not keep the passage open and cause a backflow of urine; this issue had been noticed during the concept development. They mentioned that it was packages made of thin materials that more often caused backflow because the films had a higher tendency to stick together.

As the catheter was pulled out of the package, E1 was concerned about how vulnerable the catheter tube became while pulling it out from the tip. They say it can mess with the user's mind since their mental model is based off pulling the catheter out by the connector.

E1 commented on the need of pushing back the catheter into the package after the user has taken it out of their urethra. It is assumed that this is something users would not like to do, especially if they are not in their home

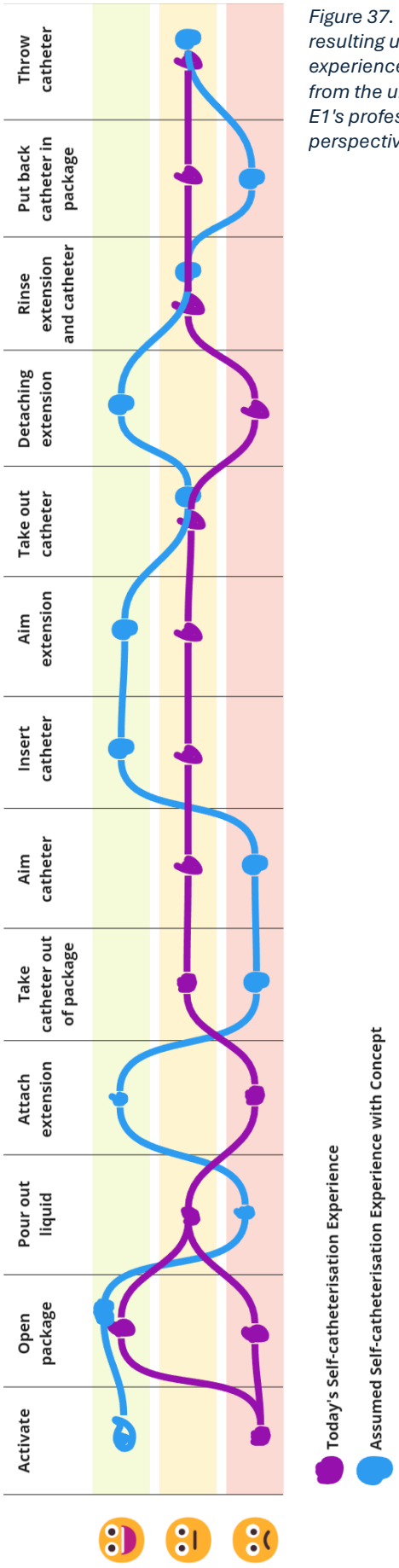


Figure 37. The resulting user experience curves from the urologist E1's professional perspective.

environment where they easily can take care of their hygiene. Also, the prototype requires a pincer grip to push in the catheter which cannot be executed by the users.

As for the grip options, E1 was satisfied with how many options the user had. However, they mentioned that the most common grip was the pencil grip, but when users are learning to manipulate objects at the beginning of their SCI, the other grips are more common to use. The gripability of the product could therefore be suitable for users of different SCI maturity levels and be used by newly injured patients as well as users who have had their SCI for many years.

The multi-purpose sticky tab pleasantly surprised E1, mostly for its ability of keeping the extension in place on the toilet seat.

When asked about having a female version of the prototype, E1 enthusiastically said yes, thinking it would be a good idea. They added that female tetraplegics need to take off their pants and lean back a lot in their wheelchair to get the right angle and distance from the toilet. Female tetraplegics have a higher risk spilling urine in their wheelchair compared to male tetraplegics.

6.7.1 Comparing Today's Experience Against the Expected Experience with The Concept

Expert E1 filled in a user journey shown in figure 37 about today's experience of the user journey (in purple) before seeing the functional prototype. After seeing the video of the concept, they filled in their perspective on the user experience during the user journey (in blue) when using the concept.

As a result, E1 thinks it is likely that the concept would perform both better and worse than today's catheter products. Most

importantly, E1 believes that the concept will perform well when it comes to the extension tube feature. It is because the user does not need to struggle with attaching or detaching an extension and can secure its position on the toilet seat without asking for assistance, says E1.

The method of pulling out the catheter by the tip can be different to many users' existing mental model. It might require a slightly different angle or movement of the arm for the user to avoid touching the bare catheter tube as it is pulled out of the package. However, this could be a part of the learning curve when users learn to use new catheter products. Although, E1 did seem a bit concerned of how vulnerable the catheter tube seemed to be when pulled out by the tip. E1 was not convinced that the users, who have low core and arm strength, are able to pull out a long catheter and keep it held up in the air without contaminating it.

A big issue with the concept when throwing it into the trash, is the fact that the user needs a pincer grip to pinch the tube and push it into the package. As of now, the catheter connector gets stuck at the opening which helps the user to pull the lid off the catheter tip. The connector being attached to the opening is also useful when the user inserts the catheter into urethra; users can feel safe that the catheter will not slide out of place. However, the connector being stuck poses a problem if the user wants to tuck away the catheter into the package and throw it in the trash bin neatly.

Some additional comments were made about certain steps. Catheters that manually need to be activated are not considered as first-hand choices for these users. When it comes to opening a package, it is difficult to open when there is nothing to hook a finger in. Many users probably do not pour out the activation liquid at all and maybe the concept should not have it as a required step. A tetraplegic needs to use a specific grip to avoid spillage when taking out a catheter.

In the evaluation, expert E1 seemed to have an overall positive reaction toward the concept, even calling it innovative. They confirmed that it tackles a barrier to a more independent self-catheterisation experience for many tetraplegics. Several positive and negative aspects about the concept were identified from this evaluation and from the duration of the concept development, which are presented below:

Positive Aspects:

- The package is multifunctional (grip aid and extension tube)
- Straps to separate the plastic film to open package more easily (than just holes)
- No need to lubricate or activate catheter.
- Multiple grip options
- Extension stays in place with sticky tab

Negative Aspects:

- Users potentially having a difficult time taking out the catheter due to poor balance.
- The catheter being vulnerable to contamination.
- The need for a pincer grip.
- The risk of backflow
- The visibility of the catheter.

6.8 The Final Concept

During the concept development, different features were explored to see how it would affect the design's adjustability for different grip preferences, discretion, and reliability. Additionally, design choices were made to optimize the user's time spent in the bathroom by increasing the user's control of the product and therefore enabling a more efficient user journey. The final prototype which was made for the design is shown in figure 38 and the final concept's appearance and features are shown in figure 39.

The Final Concept's Features

- Pre-wet catheter
- Package converts into extension tube.
- 60-70 cm long extension
- Extension is attachable to toilet seat
- Multiple grip options
- Easy to open.
- Lid with finger hook to pull out catheter
- Available with male or female catheter
- Opaque package for discreetness
- A window for visual feedback

The description below describes the 10-step instructions of how to use the catheter.

How To Use the Final Concept

1) Unfold the package.
2) Open package at the top by inserting your fingers into the strap and finger-sized hole to pull apart the seal.
3) Pour out liquid into toilet.
4) Attach extension to toilet seat by using the sticky tab that became exposed after unfolding the package in step 1.
5) Choose a comfortable grip by inserting your hand(s) through one or more of the straps, or use a pencil grip above the catheter lid.
6) Insert a finger in the catheter lid, twist the lid and pull out catheter until lid pops off.
7) Self-catheterise. Use the transparent window in the packaging to see when the urine starts and stops to flow.
8) Once the catheter is outside of the urethra, push the catheter back into the package.
9) Fold package and reuse the sticky tab to keep it folded.
10) Throw in trash.

Figure 38. A prototype of the final concept. Before throwing the catheter, the package is folded (below) to take up less space in the trash.

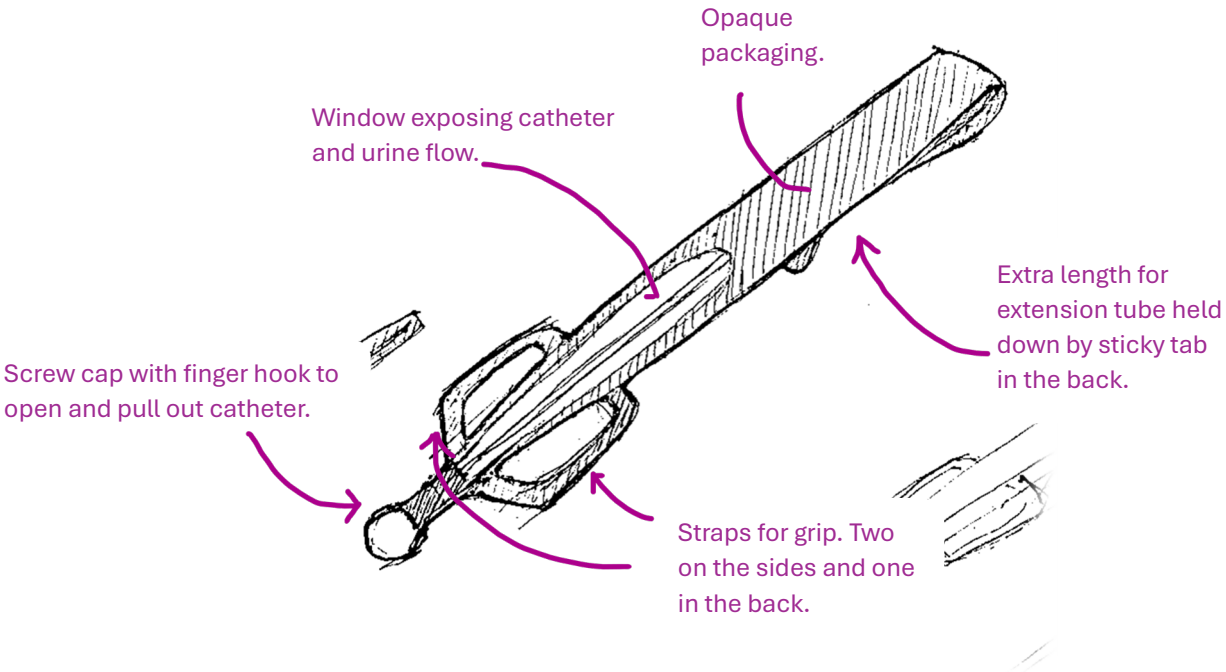


Figure 39. A sketch of the final concept with the features produced from the idea and concept development.

6.8.1 A Pre-wet Catheter in a Packaging which Converts into an Extension Tube

The final concept (fig. 38 and fig. 39) is a pre-wet hydrophilic catheter solution whose packaging converts into an extension tube that makes it possible to urinate directly into the toilet from a wheelchair. Based on user research, a pre-wet catheter increases the likelihood of the product becoming a first-hand choice for user's who are just starting to learn self-catheterisation as pre-wet catheters make the process simpler and more straightforward, both in terms of ergonomics (physio-pleasure) and cognitive efforts (psycho-pleasure). The final concept supports the identified pleasures and displeasures as *striving toward independence* and *not wasting time on peeing* from Phase One.

The swift movement of converting the packaging into an extension improves the overall efficiency and effectivity for assisted users. To add, this concept is possible to use for whoever would like to urinate into the toilet without transferring from their wheelchair and is therefore beneficial for a wider audience than the user group in this study.

6.8.2 Facilitating Tetraplegic Hand Grips with Holes and Straps

The final concept offers several finger hooks and handles adapted for tetraplegic hand grips for opening and holding the product. The importance of a *counter grip* was noted during the concept development. A counter grip lowers the need of using the mouth to secure an object in place when interacting with it, especially during a push or pull motion. Placing a strap opposite to the finger hook avoided the issue of separating the film, and the user could easily get a hold of each side (see fig. 40). This solution can potentially lower the risk of the user feeling irritated and annoyed when they are in a hurry to go to the bathroom and self-catheterise and find it difficult to open.

To self-catheterise, the final concept can be held in multiple ways for the user to have a secure grip when inserting the catheter and handling the extension tube. The concept caters to varying experience levels and abilities which ultimately affects their grip preferences. For example, some users are more capable of isolating one or several fingers, while some need to use the whole palm of their hand when interacting with a catheter; the latter needs an assistive device to hold the catheter. The three-strap grip solution combined with the hard plastic cylinder connected to the screw cap makes a wide range of tetraplegic grips possible (see fig. 41). This solution could replace an assistive grip device. The multiple grip option is another feature which can create a more independent self-catheterisation experience.

6.8.3 Pulling Out Catheter

The final concept uses a hard lid with a hook for the finger (fig. 42) to open the base of the package with a twist motion and pull out the catheter by the tip. The catheter is pulled until the connector attaches to the plastic cylinder at the base of the package. This is the same cylinder to which the cap was attached to and is also the cylinder which the user can use for a pencil grip. Once the catheter is secured in the cylinder, the user continues to pull the lid by the finger hook to force the lid to pop off the catheter.

The technical feasibility of attaching a lid to the catheter tip is unknown, but a similar solution exists in today's market.

The motion of twisting to unscrew the lid can be an issue for the users depending how much force is needed to break the safety seal (that informs the user if the package has previously been opened).

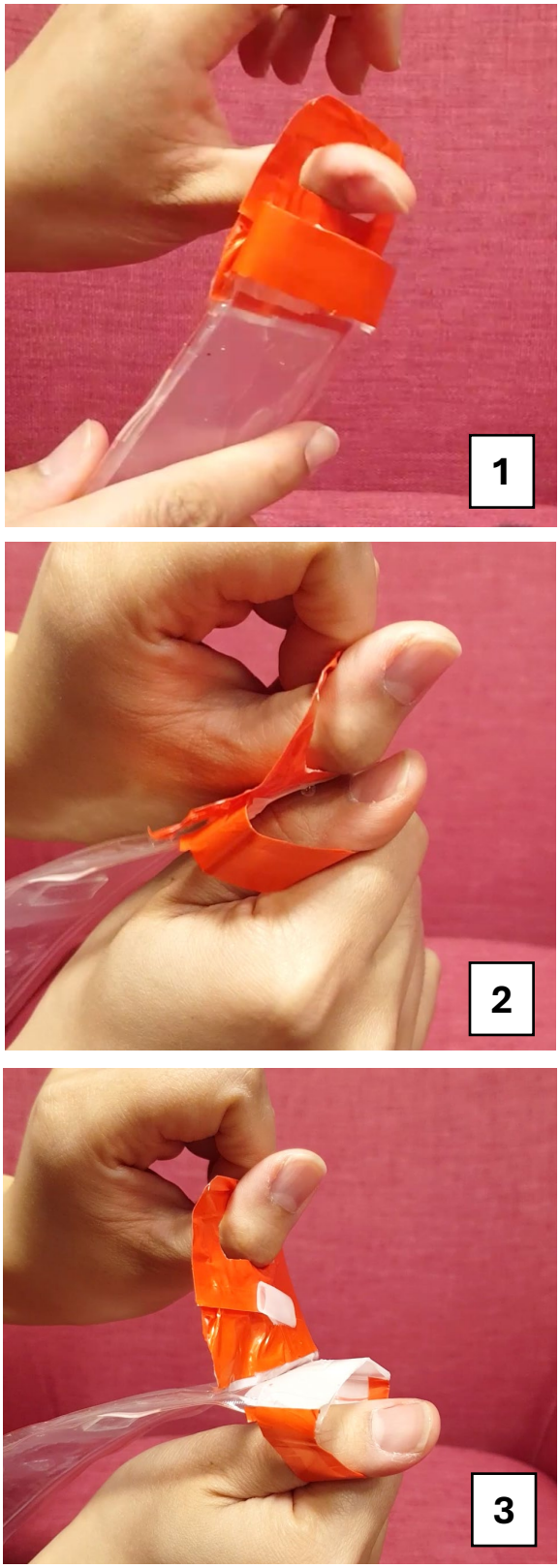


Figure 40. The possibility of inserting fingers into each plastic film makes it easier to separate them. The process above shows how to insert fingers into the hole and the strap and pull the package open.

Figure 41. Possible grips to use when handling the concept

6.8.4 Multipurpose Sticky Tab

Equipped with a multipurpose sticky tab (fig. 36), the extra length on the package is held down. The extension can also be placed on the toilet seat and stays in place when urine flows through. Once done self-catheterising, the sticky tab also helps to bundle up the catheter and extension before tossing it in the trash bin. The sticky tab helps to make the product discreet and helps lower the cognitive demand when self-catheterising.

6.8.5 An Opaque Package with a Window to for Visual Feedback

The package's appearance is made to provide discretion (socio-pleasure) and a sense of control (psycho-pleasure). It is opaque and covers the whole catheter, except for a window which is facing the user when they self-catheterise. The opaque material hides most of the catheter.

The window allows the user to see when urine starts and stops flowing through the extension. During the concept development, it was noticed that the catheter was very visible unless the package was folded. The final concept is a straight package which does not fold over the catheter; therefore, a small window was a compromise to make the catheter more hidden but still provide the user visual feedback. For optimized visual feedback, the urine should be discernible against the background colour.

Figure 42. Lid with a hook for the finger which pulls out the catheter by the tip.

6.8.6 Reflections on the Final Concept's Semiotics

Overall, this study has mainly focused on the how to handle a catheter product. However, a few reflections regarding product semiotics have been made. The ideo-pleasures *protecting privacy*, *control*, *not waste time*, *environmental sustainability*, and *social life* may have an impact on the final product's aesthetic and therefore how the user perceives the product which affects the user experience. Of course, the final product must also reflect the company's brand and what it stands for. In this case, Wellspect HealthCare portrays as a premium brand with ambitious environmental sustainability goals.

Discretion is about not letting the surroundings know that the product contains a catheter and/or is a medical product. Parallels can be made to certain sanitary pads where the individual wrappings are brightly coloured, but always opaque to hide its contents. A matte, non-reflective finish can also prevent unwanted attention compared to glossy and reflective finishes.

The colour should not feel like "hospital" or emit an expression of "medical product" because the product will be used in many settings outside a hospital. Catheters become a natural part of many users lives and is used daily. Using a product which looks like it belongs in a hospital may make the user feel *different to others* in a negative sense (socio-pleasure). A suggestion is that the product should feel as an item for personal hygiene.

Control and *not wasting time* can be connected to the user not spending time to understand the interface and quickly feel like they are in control of the product. Therefore, the interface needs to be intuitive and straightforward.

Environmental sustainability can be expressed through the choice of material. In regard to plastics, thinner plastics are perceived as more suitable as single-use products, compared to thicker plastics. Thinner plastics can therefore make environmentally aware users feel less guilty about using so many single-use products.

The product is often used in a wet and dirty environment. The user wants to make sure that their grip is secure for the product to stay in their hands. Smooth materials tend to feel slippery, even when they are dry. A suggestion is that a textured packaging material can provide a feeling of friction to reinforce the user's sense of control over the product. Whether the texture provides enough friction to secure the grip or not, is another question. Sometimes it may be enough to play with perception to increase the user's experienced physio- and psycho-pleasures from the product. In this case, a material with friction can communicate that the product is grip friendly and reinforces the purpose and benefits of other grip features.

6.9 Take Aways from Concept Development: Design Guidelines

From this study, seven design guidelines were developed to aid in future design projects for people with tetraplegia and low hand function. Of course, these design guidelines were made especially with catheter products in mind but could be applicable for other products where the users are expected to use their hands a lot.

These guidelines can be used for concept development, for example when braindrawing or creating prototypes. They can also be used when evaluating concepts, for example the concept(s) can be put against each guideline and see how well they fulfil them.

Another way to use the guidelines is for improving already existing products. Similar to concept evaluation, the existing product can be put against the guidelines to see how well it fulfils them. For instance, the product can be questioned “When does this product require a pincer grip?”. The answer could then provide what the pincer grip is used for and when in the user journey the pincer grip is used. Next, the guidelines can aid by suggesting ways to avoid the use of a pincer grip and improve product manipulation, e.g. using straps or avoiding small loose pieces.

- Each step of the user journey should be executable with one or several tetraplegic grips.
- Use hooks, holes, straps, or slim cylinders (diameter of a pencil) to enable product manipulation.
- Do not use grips which require grip strength or finger strength; for example, pincer grip or squeezing.
- The product should not be so sharp that it can cut the user’s lips, gums, or tongue if they need to use their mouth to grip.
- Avoid small and/or flat loose pieces that are difficult to pick up from a flat surface.
- Do not force the user to use two hands for one activity/step/action in the user journey.
- Do not rely on tactile feedback – use other types of feedback instead, such as visual or audio feedback.

7 Discussion

This study aimed to investigate the user experience of intermittent self-catheterisation among tetraplegics with low hand function and understand their needs and prerequisites. The four-pleasure framework was used to gain a holistic understanding of the user experience and showed to create a valuable foundation for the study and to increase the chance of designing an attractive conceptual catheter product by integrating the pleasures of independence and self-care.

The study also aimed to explore if and how a product can be designed to facilitate the self-catheterisation procedure. The final concept is therefore compared to the take-aways from the user research in phase one and common catheter products in today's market. It is also discussed how it can become a long-term product option for tetraplegics.

Lastly in the discussion, the next steps for future development such as analysing potential issues and finding technical solutions are discussed. The design guidelines are explained to how they can aid designers in future design projects for catheter products.

7.1 The Four-Pleasure Framework's Effect on the Study

As Jordan intended, the four-pleasure framework provided an additional dimension to the understanding of the current and desired user experience. It gave insight to behaviour and attitudes during self-catheterisation, in activities of daily life, and activities directly connected to self-catheterisation.

The framework supported the study to go beyond cognitive and physical usability aspects and dive into values and social attitudes that may affect the user's opinions about certain products. For example, environmentalism is an important aspect when choosing a catheter product. If the user can manage without, they prefer when the product does not have a lot of extra items, such as water sachet, gloves, etc. The user does not want to use and dispose more material than necessary when catheterising.

While exploring features for the final concept, the understanding of the current user experience helped to take on a user perspective when assessing various design solutions. For instance, the researcher could evaluate what effect a certain design choice would have on the final concept's attractiveness and the potential pleasure(s) it could provide the user. Many of the features have the potential to answer to several pleasures. For example, to open the final concept the user just needs to insert their fingers and pull apart the plastic films. This feature provides the physio-pleasure of easily using both hands to grip the plastic films and separating them. This type of accessibility lowers the risk of psycho-displeasure, e.g. negative feelings such as frustration of not opening the package quick enough or disappointment for not easily being able to open the package independently. The latter taps into the ideo-pleasure of independence, which was analysed to be the most important value among users. Knowing what the users find pleasurable increases the chance of creating features which may create several types of pleasures and thus increase the attractiveness of the product (Jordan, 2000).

If this study was executed without the perspective of the four-pleasure framework, it would be likely that the user research would

not encompass an equally wide perspective of the user experience. Even though the user research probably would have gained a glimpse into user preferences regarding discretion and independence, it would not comprehend their importance to the overall user experience. This would result in a final concept that might fulfil usability-needs for self-catheterising, but not fit seamlessly into the user's life.

7.2 The Final Concept

The final concept offers an all-in-one solution, so the user always has what they need to catheterise. If the user is not able to transfer to the toilet, using the extension tube is the only way to pee directly into the toilet. In today's market, catheters and extension tubes are sold separately which forces the user to attach and detach the extension tube to the catheter every time they need to empty their bladder, e.g. every 4-6 hours.

The current market offers pre-attached urine bags that are useful for those who don't want or cannot attach a separate urine bag. This final concept fulfils the same need to have the catheter product prepared in its entirety (pre-wet and pre-attached extension tube). A ready to use, all-in-one, catheter product provides added value for the user so they can urinate directly into the toilet from a wheelchair without the need to go through the hassle of attaching, detaching, and cleaning an extension tube or the inconvenience of opening and emptying a full urine bag.

With this all-in-one type of concept, the user does not need to navigate three different products each time they catheterise (the catheter, assistive device, and extension tube). It's adjustability to multiple hand grips increases the chances of urologists and nurses suggesting the conceptual product to both inexperienced and experienced self-catheterisers with low hand function.

Multiple Grip Options Can Lead to Long-term Users

The multiple grip option makes the final concept potentially useful for tetraplegics at different stages of their SCI, e.g. newly injured or been living with the injury for years. The concept may be able to cater to the user's changing grip preferences as the injury changes and they learn new grip techniques, which was mentioned by an expert (E1). This means that once a patient starts using the concept, it is likely that they become a long-term user because of the concept's adjustability.

Reflecting Upon a Full Sleeve Solution for the Catheter

The evaluation with the urologiss revealed that the catheter can be vulnerable to become dirty when pulling it out of the package. A solution is to cover the tube with a full sleeve simultaneously as it is pulled out of the package. The user can then pull out the catheter without worrying about accidentally touching the tube and increase the risk of a UTI. It could therefore lower the cognitive efforts of keeping the catheter tube "safe" before self-catheterisation.

Whether a sleeve is an attractive option or not depends on how easy it is to manage with low hand function. In the workshop, users expressed that full-sleeved catheters are messy and require both hands to feed the catheter into the urethra when they would rather have the option to keep one hand free. At the same time, experts said that it is a question of learning a new technique, and once users have gotten by the hump of the learning curve, they love having a sleeved catheter. Ultimately, opting for a full sleeved catheter was undecided for this concept.

7.3 Relating the Final Concept to Phase One's Take Aways

Regarding how the final concept affects the user groups, it should benefit both assisted and independent user groups. The assisted user group should have less of a need for assistance during the self-catheterisation as the concept is adapted to tetraplegic hand grips throughout the whole user journey to improve ease-of-use. Thus, increasing the chance of independently interacting with the concept. The independent user group may experience quicker bathroom visits since they will not need to attach, detach, and clean a separate extension tube each time they need to pee. The features adjusted for tetraplegic hand grips will allow independent users more efficiently interact with the product and shorten the time at the toilet.

The final concept could be adapted toward both female and male users and be used for catheterisation through a mitrofanoff-channel. The features made for tetraplegic hand grips do not exclude hand grips of similar or higher function, thus making this conceptual product useful for most people who may need an extension tube by either necessity or choice. For example, it could be used by paraplegics who may not want to transfer to a toilet. Therefore, the final concept could potentially be useful for other user groups outside this study.

Concerning the two UX-goals, it cannot be decided to what degree the concept fulfils the first UX goal, "*Enhance the experience of independence in activities of daily life and throughout the user journey"*, without further evaluations of the concept together with users. As for the second UX goal, "*Preserve the user's privacy by addressing aspects of product discretion before, during, and after the user journey"*, it is doubtful if the final concept can fulfil this goal. The concept does partially conceal the catheter tube with the opaque packaging and hides the conceptual product's purpose. The length of the concept could be hidden under a wheelchair but may be more difficult to pack into a bag without the product taking up a lot of space or poking out of the bag.

Lastly, one take-away was to make the user journey shorter. The user journey with the final concept is estimated to be shorter because it has become more alike a user journey where only a catheter is used (without an extension tube). Throwing the concept is a bit difficult since it requires a pincer grip to reinsert the catheter into the packaging, thus prolonging the time spent in the bathroom.

7.4 Differences Between Participants' Opinions of Throwing Neatly

Throwing the catheter neatly seemed to divide users and expert participants. Some users are taught early on by healthcare professionals that it is unhygienic to not throw it wrapped up. Most participants agreed to this, but the users' experiences revealed that many users throw the catheters uncovered. This could be because used catheters do not evoke the same feeling of disgust as it does among those who wrap up their catheters before disposal. Or maybe, they have not been taught how to dispose catheters hygienically, meaning there could be differences in self-catheterisation education.

A catheter product could encourage the user to dispose it hygienically by informing instructions on the package. The instructions should require very low effort to see and understand to lower the barrier for the user to throw hygienically. Offering instructions on the package may create an understanding of what the norm is "supposed" to be when disposing catheters.

7.5 Surprisingly Negative Attitude Toward Assistive Devices for Self-Catheterisation

Early in the study, it was assumed that the final concept might be an assistive device. But after the interactions with the study participants revealed that assistive devices are a necessary evil and that users would rather not have them. Initially, these opinions were not expected and therefore came as a surprise.

It is believed that it is the tediousness of the assistive devices that create these negative feelings. Using an assistive device is a process in itself, where the user needs to have space to store it, put it on and take it off, and clean it every time they need to self-catheterise. So, it is not necessarily the product itself that is the problem, but rather the frequency and length of the interaction with the assistive device.

In addition to the tedious process, the assistive devices seemed to be unreliable and not provide sufficient control of the catheterisation as they were supposed to do. The user may not want to spend time dealing with an assistive device when it does not fulfil its purpose.

The final concept is an embodied suggestion of how to enhance the user experience. In the end, it is considered that an assistive device could be a great option to facilitate self-catheterisation if the user does not need to go through a tedious installation process each time they go to the bathroom. In other words, an assistive device could potentially enhance the user experience, if it is not cognitively and physically demanding, prolongs the process, and is consistently effective.

7.6 User Participant Scarcity Weakens the Study

There were difficulties gathering user participants for the study, both because it is a unique user group, and that self-catheterisation is a sensitive topic. This narrows down the number of people able and willing to share their experiences and opinions. Only two users were tetraplegic, had low hand function and self-catheterised. If more users participated in the study, it would have increased the possibility of finding different insights and more patterns within the data. More users would have given a stronger, more validated result which in turn would increase the potential for a more solid conceptual design. However, it is believed that the study reflects key user needs.

A lot of time was spent on searching for users which prolonged the project. A suggestion for similar studies of a sensitive nature, is to ensure there are users available to partake before the project starts.

7.7 Next Steps to Take for Future Development

This study produced a highly conceptual design based on a very small sample set, so the next step is to do further user research to validate the findings. Regarding the final concept, user testing is needed to understand the concept's ease-of-use and analyse issues that may arise throughout the user journey, for example, extension tube not sticking to the toilet seat, backflow, catheter not staying attached to the extension tube during catheterisation, etc.

Two big challenges with the concept are pulling out the catheter by the tip and pushing back the catheter into the packaging before throwing it. A technical solution needs to be developed to enable the user to pull out the

catheter by the tip without damaged the catheter tubes surface. Additionally, pushing back the catheter into the package needs further ideation, a suggestion from a Wellspect employee is to somehow crush the plastic cylinder, which is holding the connector, so the connector gets loose.

The design guidelines are created to facilitate future design projects for catheter products for this user group. They specifically focus on enabling product manipulation based on tetraplegic hand grips and could be applicable to products requiring hand usage, not only catheter products. The purpose of the guidelines is to remind the designer(s) to consider how a product becomes suitable for tetraplegic hand grips throughout the entirety of a user journey. Of course, which design guidelines are relevant, and their prioritisation are based on what type of product is being created.

Most importantly, enabling the users to manually manipulate a product whenever necessary may draw out feelings of (product) pleasure, decrease displeasure, and increase the overall product attractiveness.

8 Conclusion

Today's catheters disable capable tetraplegics from self-catheterising independently. The experience of self-catheterisation is tedious, filled with worry and frustrations as the products and process are not optimized to be effective nor efficient for tetraplegic hand grips. Enabling tetraplegic grips throughout each step of the user journey would increase the ease-of-use and lower the need for assistance.

The action of attaching an extension tube or urine bag, which many tetraplegics need as they cannot easily transfer to a toilet, demands for a pincer grip or a bite grip. Eliminating this step from the user journey will allow more tetraplegics to experience increased independence and less hassle when catheterising.

Increasing tetraplegics' ability to quickly and independently catheterise may lower negative emotions when partaking in activities of daily life since they would worry less about bathroom visits, and thus improve their quality of life.

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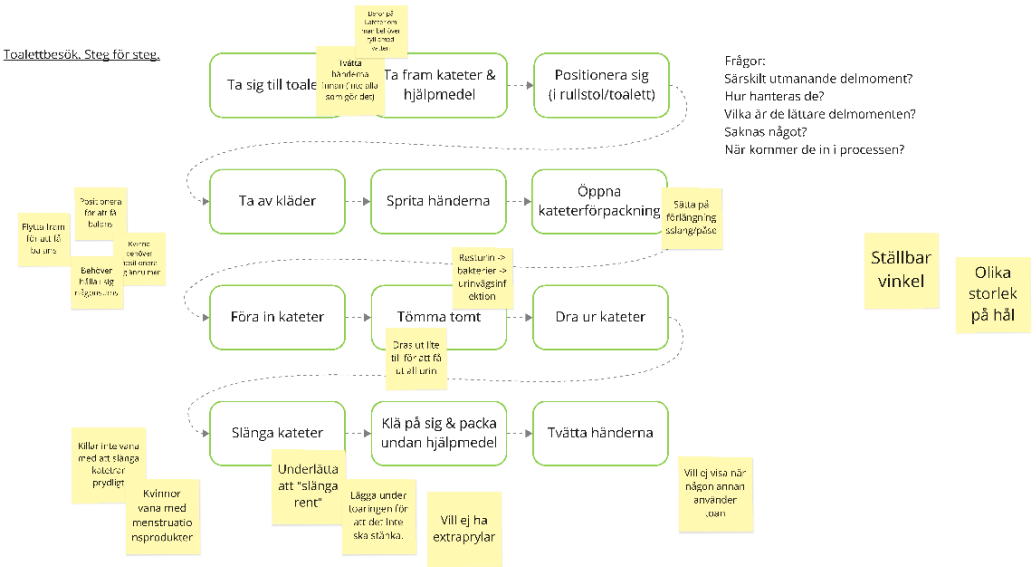
Appendix A: Focus Group Presentation with Notes

- Introduktion
- Block 1: Hur ser det ut idag?
- Block 2: Dagens marknad
- Block 3: Önskedrömmar
- Sammanfattning & Avslut

BLOCK 1: Hur ser det ut idag för tetraplegiker med låg handfunktion?

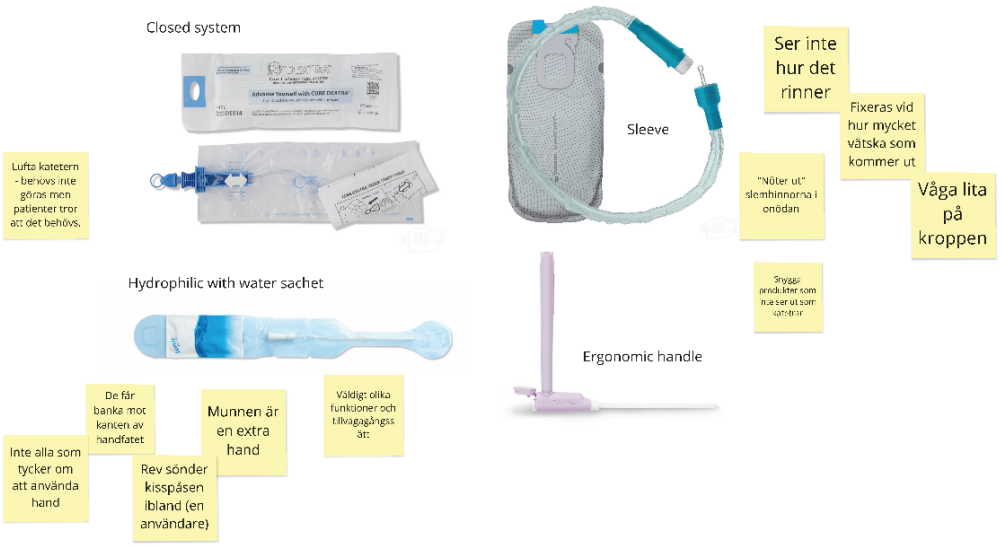
20 min



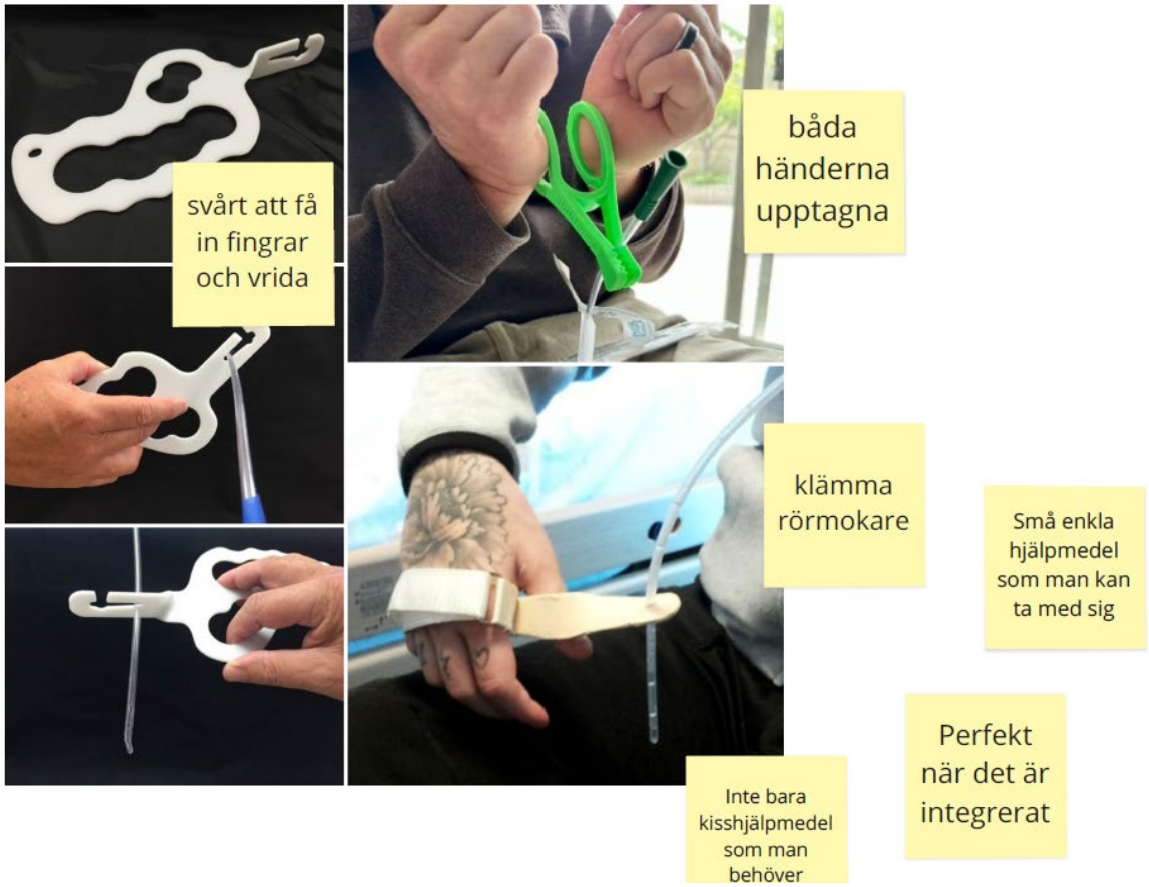
BLOCK 2: Dagens Marknad

20 min

Fixa fysiska exemplar



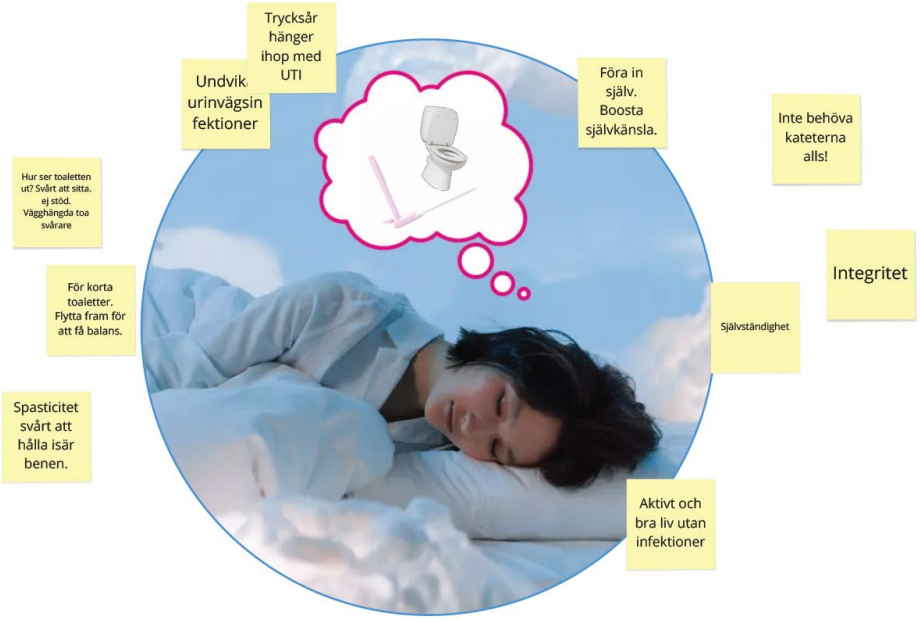
Kateterhållare



Olika grepp

BLOCK 3: Önskedrömmar

5-10 min



Appendix B: Workshop Structure

Workshop

Datum: 13:e december
Tid: 10.00-12.00
Var: Aleris Rehabstation Stockholm

Fixa en klocka att titta på. Armbandsur.

Skapa bonusaktivitet

Schema

INTRODUKTION		**10 min**
Presentera workshop och projekt och regler		5 min
Presentera varandra		5 min
BLOCK 1: UNDERSÖKA UPPLEVELSER		**35 min**
Introducera aktivitet		5 min
Dagens läge? & User Journey	*Helgrupp*	10 min
Geneva Emotion Wheel	*Individuellt*	10 min
Dela och diskutera	*Helgrupp*	10 min
PAUS…		**10 min**
Frukt, pepparkakor, kaffe och te		
BLOCK 2: MIX 'N' MATCH		**50 min**
Introducera aktivitet		5 min
Kläm och Känn	*2-3 personer*	15 min
Mix 'n' Match	*2-3 personer*	15 min
Presentera och diskutera idéer	*Helgrupp*	15 min
SUMMARY		**15 min**
THANKS & GOODBYE		**5 min**

Introduktion

Hej!

1. Berätta om projektet
2. Syftet med workshop: Samla in era erfarenheter och åsikter kring hur en kateter kan se ut
    a. Schema
    b. Regler: Öppensinnade, icke dömande miljö och ni väljer precis hur mycket ni vill dela med er.
    c. Samtycke om inspelning. Anonymiserad data. Kan dra sig ur när som helst.
3. Berätta om mig själv
    a. Facilitator och min roll idag är att lyssna på vad ni har att säga.
    b. + ICEBREAKER 2 sanningar 1 lögn (vad är icebreakern?) och så ska ni gissa vilken är lögnen.
4. Berätta om er, varför ni ville vara med idag och icebreaker.

Aktivitet 1: Dagens läge? & User Journey

INSTRUKTION: Först ska vi kika på hur det ser ut idag för er. Här är olika steg i kateteriseringen. Berätta gärna om jag har missat något.

Vad använder ni idag?

Vad funkar bra? Vad funkar mindre bra? Vad funkar inte alls? Är riktigt dåligt?

Finns det något på pappret som funkar bättre eller sämre?

Siktar ni med en eller bägge händer?

Hur undviker ni kisstänk?

Vad tycker ni om att katetrar är engångsprodukter?

Aktivitet 2: Geneva Emotion Wheel

INSTRUKTION: Nu ska vi titta på känslor i olika situationer med avseende på kateterisering och vi ska använda Geneva Emotion Wheel *visa papper*. Ni ska svara på dessa individuellt.

Ni ska föreställa att ni ska gå och kissa i 4 olika situationer. Ni är på toa och ska kateterisera. Ta av kläder, ompositionera, tvätta händer, slänga efter er, m.m. Tillgängligheten, renligheten och ovissheten kan variera mellan dessa situationer. Vilka känslor uppkommer?

1. **Kateterisera i hemmet**
2. **Kateterisera när du är på din sysselsättning (jobbet, studier, eller annan vardagsysselsättning)**
3. **Kateterisera under fritidsaktivitet (restaurang, gym, resa)**
4. **Kateterisera i en situation du gärna undviker. OM ni har det.**

Våra känslor kan ibland vara blandade och eventuellt innehålla flera komponenter.

Vänligen uppskatta intensiteten av dessa känslor som du har känt, även om intensiteten varierar mellan dem. Om du inte kände några känslor alls, vänligen kryssa för den övre cirkelhalvan i centrum av hjulet (märkt "Inget"). Om du upplevde en annan känsla som är annorlunda mot existerande känslor i hjulet, vänligen kryssa för den nedre cirkelhalvan i hjulets mitt (märkt ”Annat”).

När alla är klara med att fylla i känslorna, kommer vi att tillsammans diskutera vad som är bra eller dåligt i de olika situationerna och vad som saknas för att göra de ännu bättre.

Svara gärna spontant, med det första som ni tänker på och utan att tänka alltför mycket. Ni kan börja nu 😊

De ifyllda känslohjulen kommer att samlas in för vidare analys.

Diskutera:

Berätta var är det **bästa** stället att tömma blåsan? Varför?

- Vilken/vilka är de starkaste känslorna? Varför?

Berätta var är det **sämsta** stället att tömma blåsan? Varför?

- Vilken/vilka är de starkaste känslorna? Varför?
- Hur gör du för att hantera dessa känslor? Tillvägagångssätt?
- Hur skulle vi kunna göra så att du känner dig mindre… *känsla*?

Finns det en aktivitet eller **ställe du undviker**? Varför?

- Vilken/vilka är de starkaste känslorna? Varför?
- Vad behövs för att det ska kännas bättre?

Aktivitet 3: Kläm & Känn

INSTRUKTION: Här har vi en mängd olika prylar. Vi ska nu analysera dessa utifrån olika perspektiv/kategorier vilka som känns bra eller dåliga.

Placera ut papper grön och röd så att de kan sorteras under varje kategori. *ta kort*

- Grepp
- Vrida
- Trycka ihop
- Dra
- Tillåter flera grepp
- Storlek
- Material
- Vikt
- Greppmotstånd

Aktivitet 4: Mix 'n' Match

INSTRUKTION: Nu ska vi gå igenom olika kontexter och så ska vi plocka ut produkter som vi tror skulle passa.

Kontext 1: Tänk att ni ska sätta ihop en kateter med en urinpåse eller en förlängningsslang. Vilka grepp skulle ni föredra?

Kontext 2: Om ni skulle dra av en slang eller urinpåse, vad för grepp här skulle underlätta det?

Kontext 3: Vilka grepp här skulle underlätta att sikta katetern?

Kontext 4: På vilka sätt föredrar ni att öppna en förpackning?

Kontext 5:

Bonusaktiviteter och frågor

Hur skulle den optimala katetern vara för er?

Summary

- Ta upp det vi har pratat om i varje aktivitet i stora drag.
- Jag kommer att analysera inspelningarna och om det är något jag behöver förstå bättre så kan det hända att jag kontaktar er.
- Är det något vi har missat att ta upp?
- Har ni några frågor?
- Biobiljetter

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