

PeriPal

Home Peritoneal Dialysis

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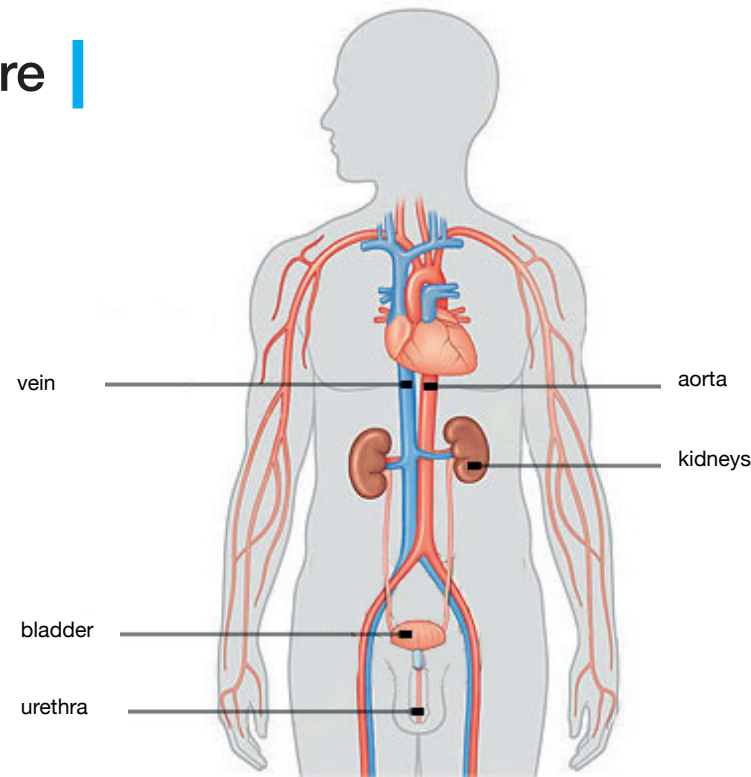
in cooperation with
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ETH pdZ

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| RESEARCH |

Chronicle Kidney Failure



Kidneys

About 1500 liter blood is streaming through the kidneys of a human in a day. The main task of the kidneys is to filter and clean the blood to get rid of harmful substance. Apart from the detoxication, the kidneys also controll the balance of the water in the body, the blood pressure and the hematosis through hormones.

Dialysis

If the kidney function is bellow 15%, a kidney renal treatment is essential for survival.

Patients

In Switzerland 3400 people need a dialysis. These are 0,04% of the population. The number of new patients is raising by 12% each year. The dialysis treatment makes 0,33% of the hole healthcare costs.

Cause

The most common cause for a chronicle kidney failure is high blood pressure and diabetes.

Transplantation

In Switzerland, a patient waits about 2-3 years for a new kidney. With increasing of the age, a transplantation becomes more and more difficult.

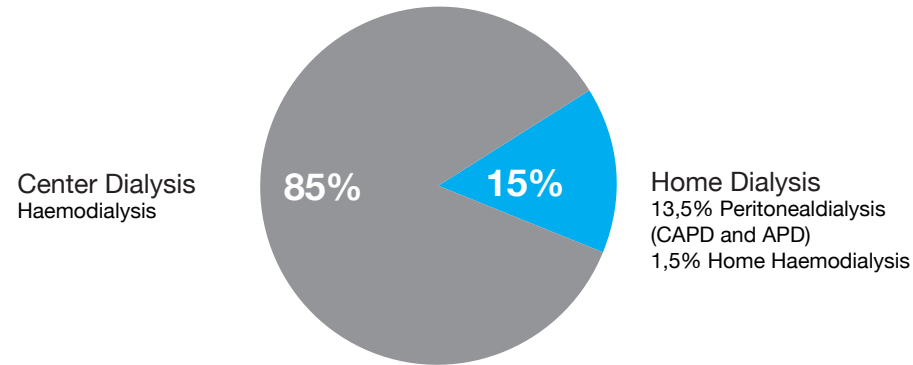
Worldwide

80% of the continuous renal replacement therapies are done in north America, Europe and Japan.

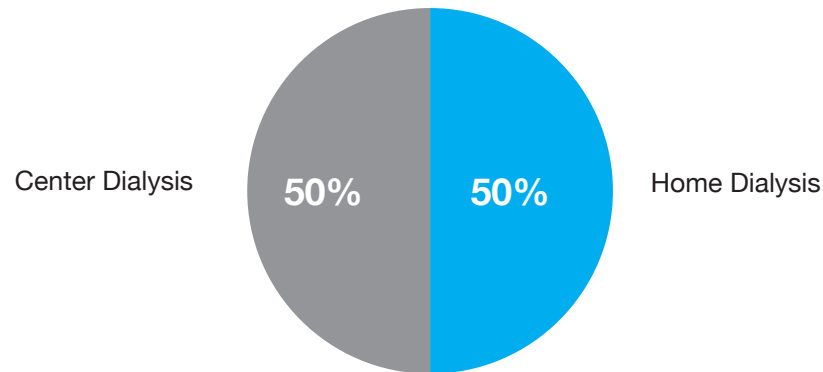
The half of new diagnosed patients are from China.

Center VS Home Dialysis

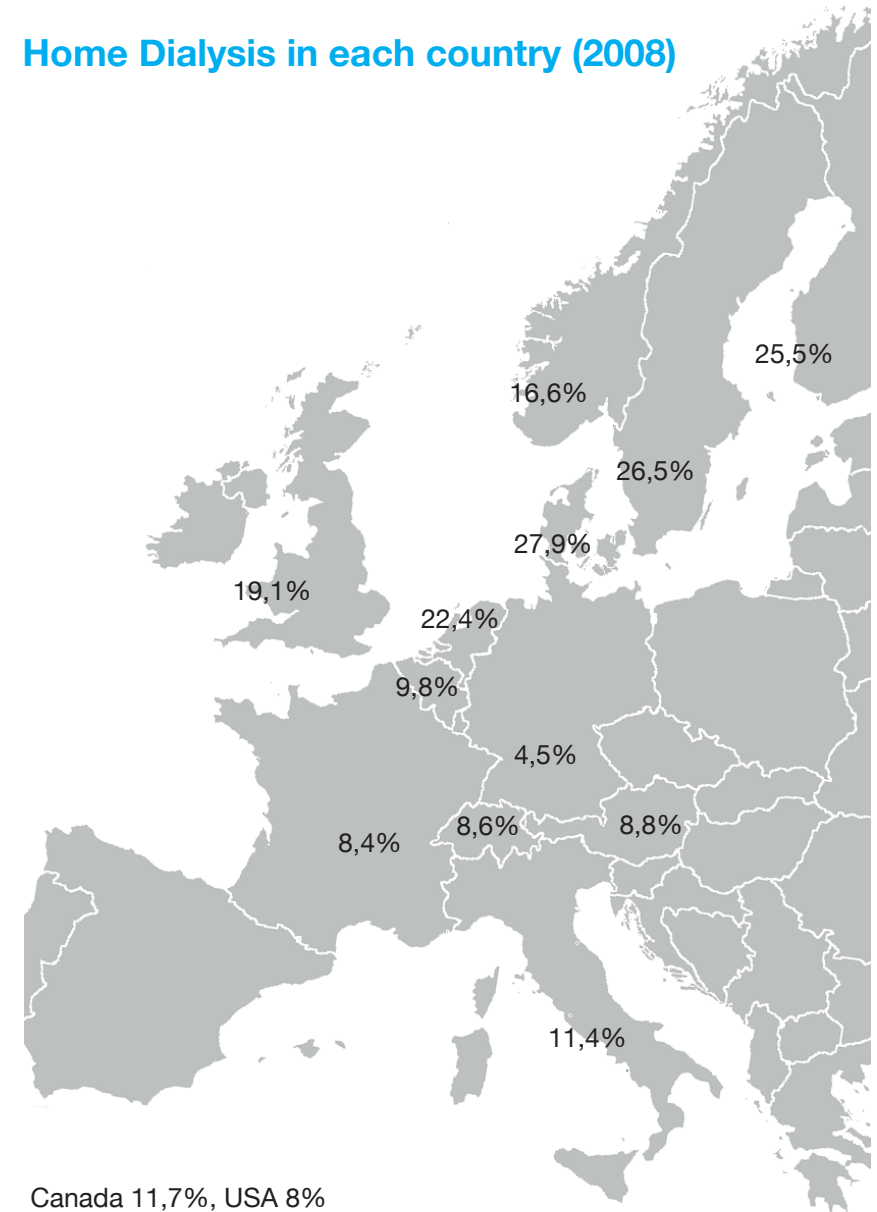
Average of treatments in the Western world (2008)



Patients position when they could choose freely (2004)



Home Dialysis in each country (2008)



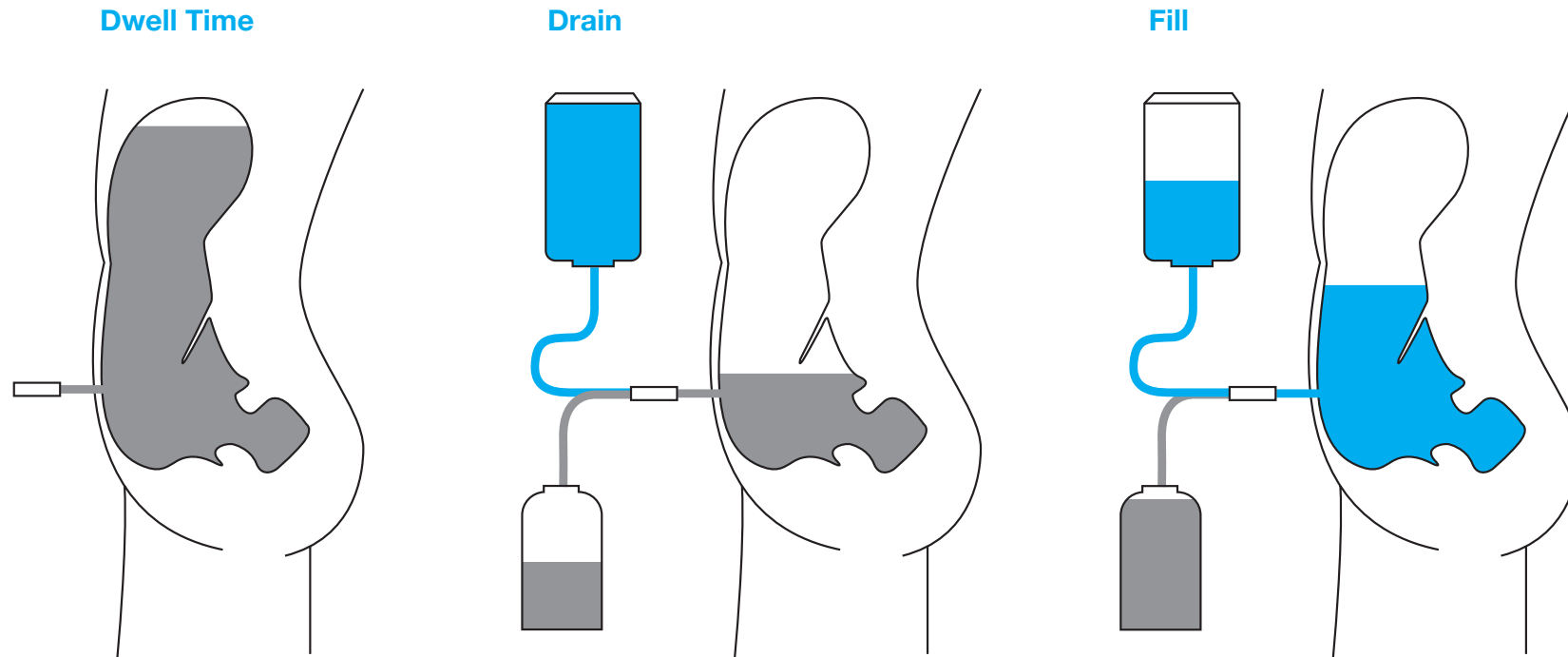
Facts

CENTER		HOME					
Haemodialysis		CAPD Continuous Ambulatory PD	Peritonealdialysis		APD Automated PD		
The blood is getting cleaned outside the body with a special filter. The requirement for the treatment is a shunt (a surgical intervention).		The blood is getting cleaned inside the body with the peritoneal filled with dialysis fluid. The requirement for the treatment is a catheter to the peritoneal and a kidney residual function. A patient has to cope with the CAPD before getting to the APD.					
8am	12am	4pm	8pm	8am	12pm	4am	8am
MO				MO			
TU				TU			
WE				WE			
TH				TH			
FR				FR			
SA				SA			
SU				SU			
3 x weekly / 4 hours		4 x daily / 30 Minutes		1 x daily / 8 hours			
+ no responsibility + no medicine devices at home - distance to the center - ups and downs - costs	+ independent + once a month a check in the hospital - the partner needs to do the dialysis - haemodialyse machine takes a lot of space ups and downs	+ independent / responsibility + once a month a check in the hospital + no ups and downs likewise the HD + no electricity needed - no more day without the dialysis - dialysis bags take a lot of living space		+ independent / responsibility + once a month a check in the hospital + no ups and downs likewise the HD + all day long no dialysis - no more day without the dialysis - dialysis bags and cycler take a lot of living space			
83'000 Fr. / year	45'000 Fr. / year	40'000 Fr. / year		60'000 Fr. / year			

Functionality of the Peritoneal Dialysis

In PD, a soft tube, called a catheter, is used to fill your abdomen with a cleansing liquid called dialysis solution. The walls of your abdominal cavity are lined with a membrane called the peritoneum, which allows waste products and extra fluid to pass from the blood into the dialysis solution. The solution contains a sugar called dextrose that will pull wastes and extra fluid into the abdominal cavity.

These wastes and fluid then leave your body when the dialysis solution is drained. The used solution, containing wastes and extra fluid, is then thrown away. The process of draining and filling is called an exchange and takes about 30 minutes. A typical schedule calls for four exchanges a day, each with a dwell time of 4 to 6 hours. Different types of PD have different schedules of daily exchanges.



Equipment

expendable items



Twin-Bag



Clamp



Gaze



Surgical Mask



Mini Cap



Sterile Solution



Band-Aid
(Catheter)

basic items



Catheter



Heating Plate



Blood Pressure Gauge



Log Sheet



Scale
(fluid)



Scale
(bodyweight)



Infusion Stand

Therapy Place

These pictures show common dialysis places. Through watching patients videos, talking to patients, it can be said that the most used dialysis room in Germany and Switzerland is a separate one. In the USA the kitchen is probably the most used place to fulfill the dialysis. Especially young patients with an office job can do the therapy during work.

hotel room



office



seperate room



kitchen



living room



Project Goal

The aim of this work is to reduce the fear of the peritoneal dialysis and to make the treatment more accessible and easier for elderly people.



Target Group

good mental condition

The patient has to be in a good mental condition, otherwise the treatment safety guidelines can not be carefully applied.

64 years old

In Switzerland the average patients age is about 64 years old. The trend shows a increasing age average every year.

Cataract

A cataract is a clouding of the lens inside the eye which leads to a decrease in vision. It is most commonly due to biological aging, but there are a wide variety of other causes.

Gout

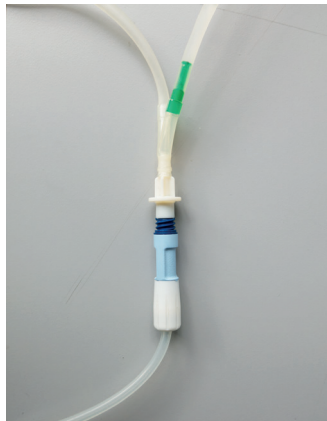
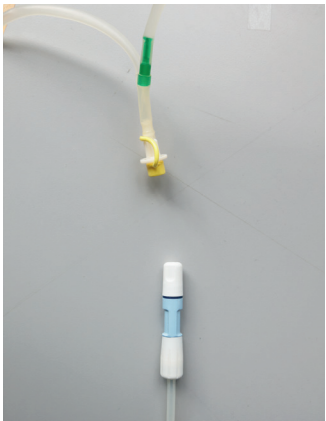
The gout affects the joints of the human body. Grabing or handling something like a mug becomes more and more difficult.

Dialysis Exchange - Self Attempt

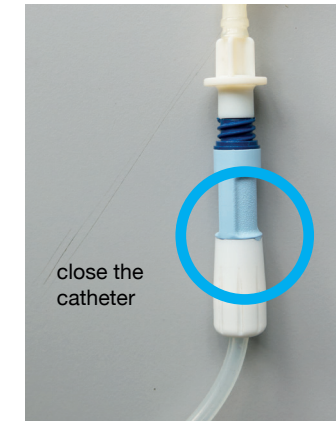
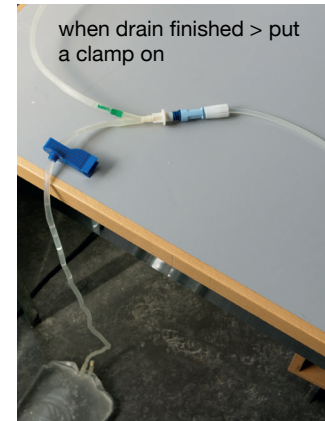
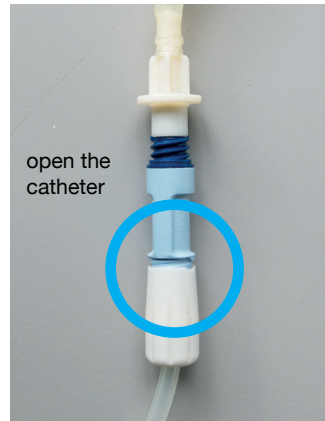
01 Preparation



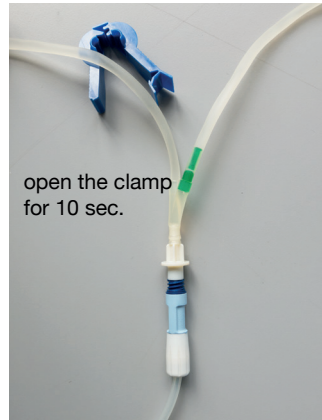
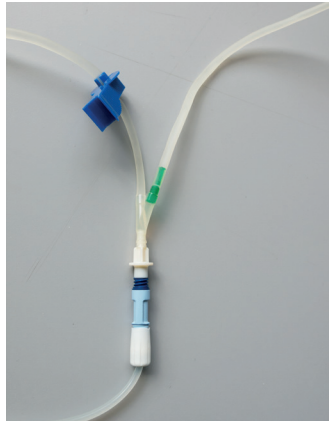
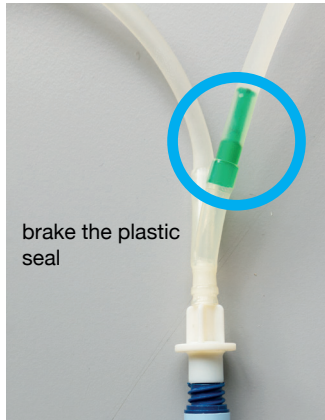
02 Connect



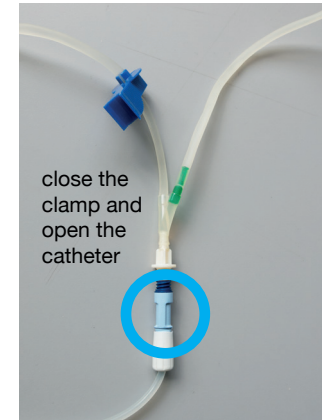
03 Drain



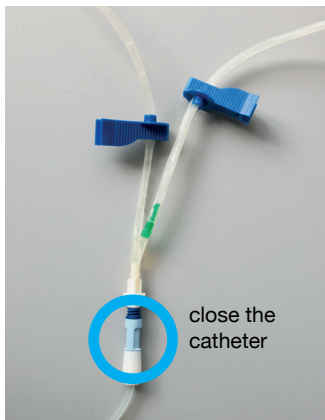
04 Flush



05 Fill



06 Disconnect



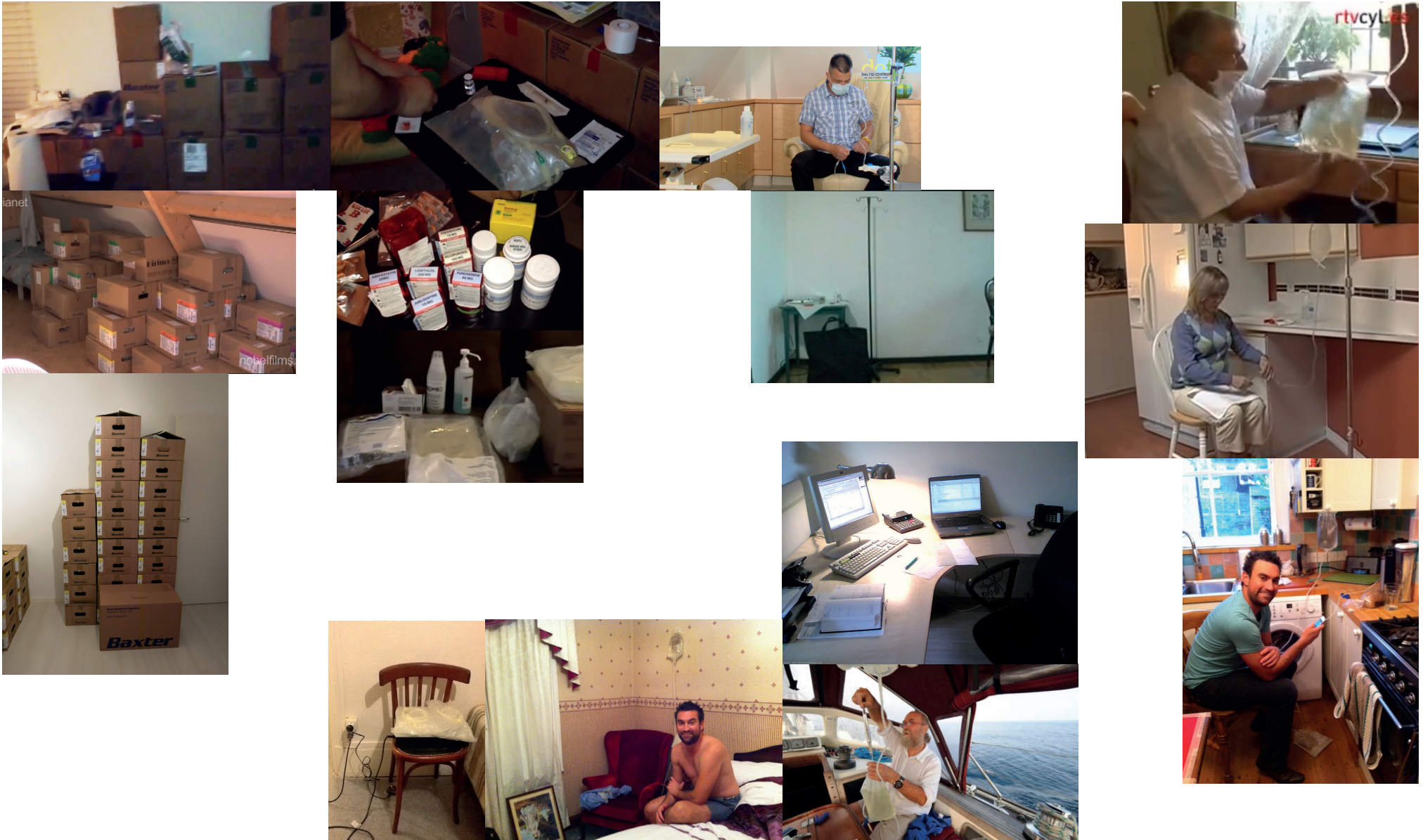
07 drain off the solution



Comments

The solution bag has to be on body temperature. Usually the patients put them on a heating plate 4 hours before starting the treatment. In each treatment the patient has to write the weight of the incoming and outgoing solution on a log sheet. The body weight and the blood pressure have to be measured once a day. The band a id of catheter usually gets changed all two days or after showering.

Field Research - Patients Videos and Pictures



storage

treatment place



organization

Research - Treatment Items and Inspiration

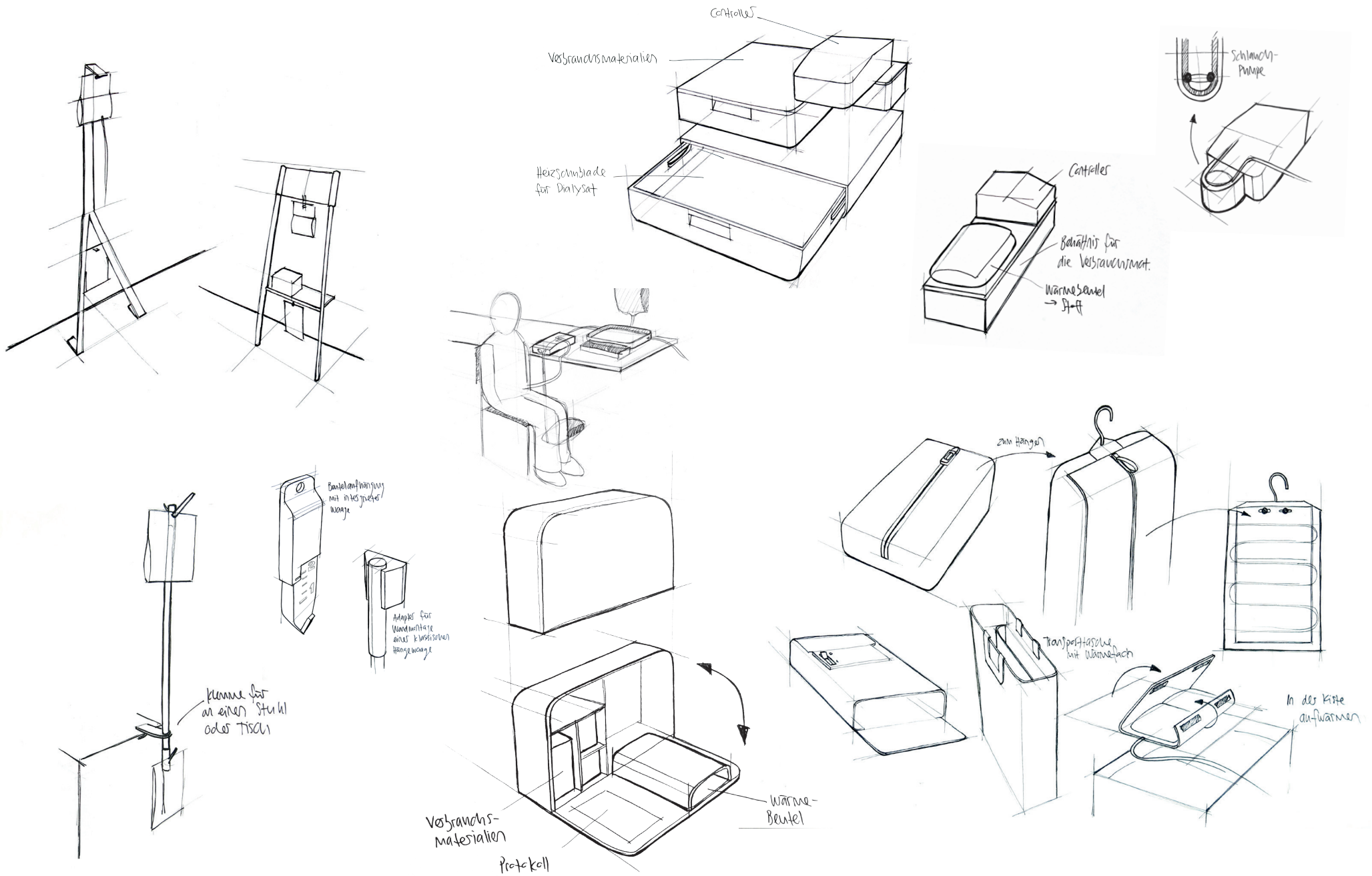




Treatment Analysis

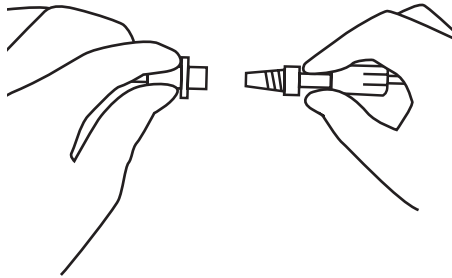


Ideation



Challenges

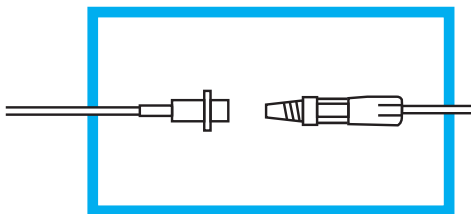
producer main supply



infection risk

The biggest issue of not doing CAPD is the fear of getting a infection or not having the ability to connect the catheter with the twin bag safely. Especially elderly patients have more problems to connect and disconnect the catheter from the solution bag.

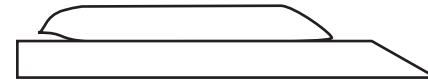
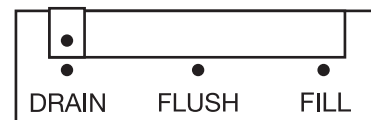
A way to minimize the infection risk is a mechanical connector with a „sterile“ space inside. This is what the ETH is developing.



complexity

To follow the right procedure of getting the clamps on and off, the tube is not handy. A controller, where the patient just has to move a regulator (image bellow), would be easier.

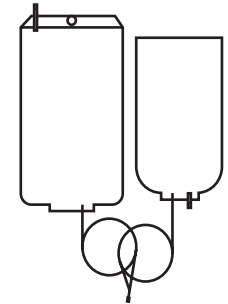
In practice, after a few trainings, it is not as hard as it looks like. Usually the handling with the clamps is teachable and it is not a big risk for the health when the patients does something wrong with the fluid. The ergonomics and the handling must be better.



heater

The twin-bag needs to be on body temperature in advance to the treatment and therefore a heating plate is needed. The actual plates function like casual hot plates. They are heavy, inefficient, need a lot of space and are not transportable friendly.

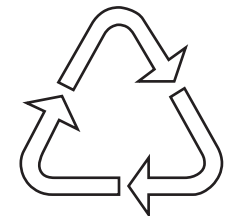
A heating bag that covers the solution completely would be more efficient and lighter.



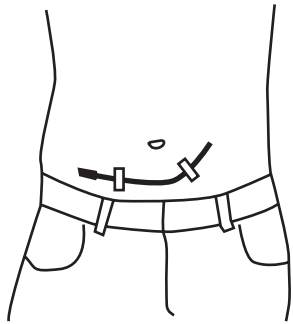
plastic waste

The twin-bag is built up PVC plastic. The patients in most countries have to dispose the bags on their own in the casual household garbage. Valuable resources get lost. PVC can be recycled for window frames, pipes and more. It would be worth to take them back into the life cycle.

An other attempt would be changing the material in a PVC free material.



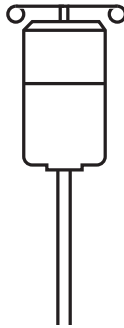
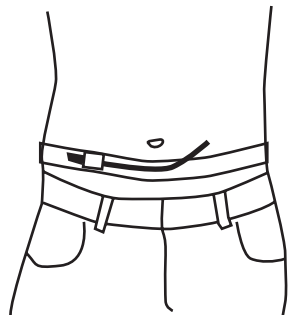
individual requirements



catheter belt

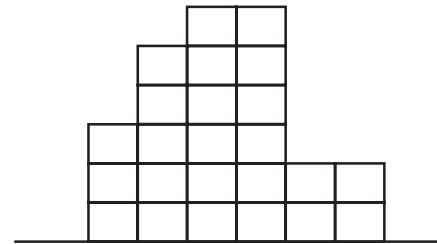
The Catheter exit in the skin is a very sensitive spot. During work or even sport, patients do want to feel comfortable and take the catheter close to the body by taping it on the skin or take a catheter belt on.

There is a big variety of different belts available in the internet. The needs of patients are wide spread.



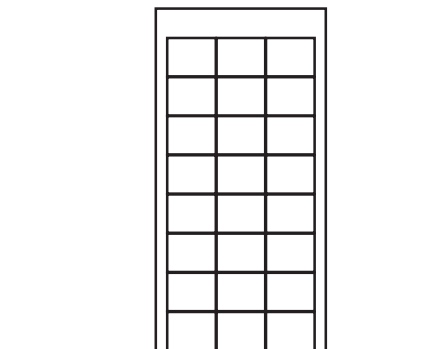
infusion stand

During the 2-3 years of therapy, patients arrange their household for the dialysis. Most of the patients have a fixed dialysis place where they have everything. That is why some patients do not even use the infusion stand. All what is needed for the solution bags is a hook on the wall or an infusion stand without bottom part with just a mount for a table.



organization

Patients receive a monthly delivery of solution bags. That means about 24 cardboard boxes at home. Furthermore, there is a lot of equipment for the treatment needed. This means a lot of living space gets lost. There can be a possibility to arrange the home treatment better and more effective, as an example a dialysis furniture or a other storage system.



Existing Products

BAXTER - UV Flash Compact

This device was especially designed to decrease the infection risk for patients that have problems to connect the catheter with the APD-Cycler. To make it even more safe, the device has a UV-flash inside. The UV Flash disinfects the catheter and plug before they get connected. For this system a Catheter with a plug (no thread) was needed. Baxter took it out of the market.



BAXTER - CXD2

It is the same as the Baxter UV Flash Compact but without Flash and electricity. To connect the catheter with the solution bag, the lever has to get pulled manually. This device also just works for the catheter with the plug. It is out of the market.



FRESENIUS - stay-save

To make the hole procedure easier, Fresenius abstains from the clamps. They use a disk to control drain, flush and fill. The user just has to turn the handle clockwise to succeed. The catheter has to be connected manually to the disk and decreases this risk a little by having mounts for the new and old cap.



Trends

APD - Mobility

Today, the cyclor of the APD is big and heavy. Recent fairs have shown companies that are on the way to make this device mobile (picture bellow). This would increase the demand of peritoneal dialysis. However, there is no such device on the market yet.

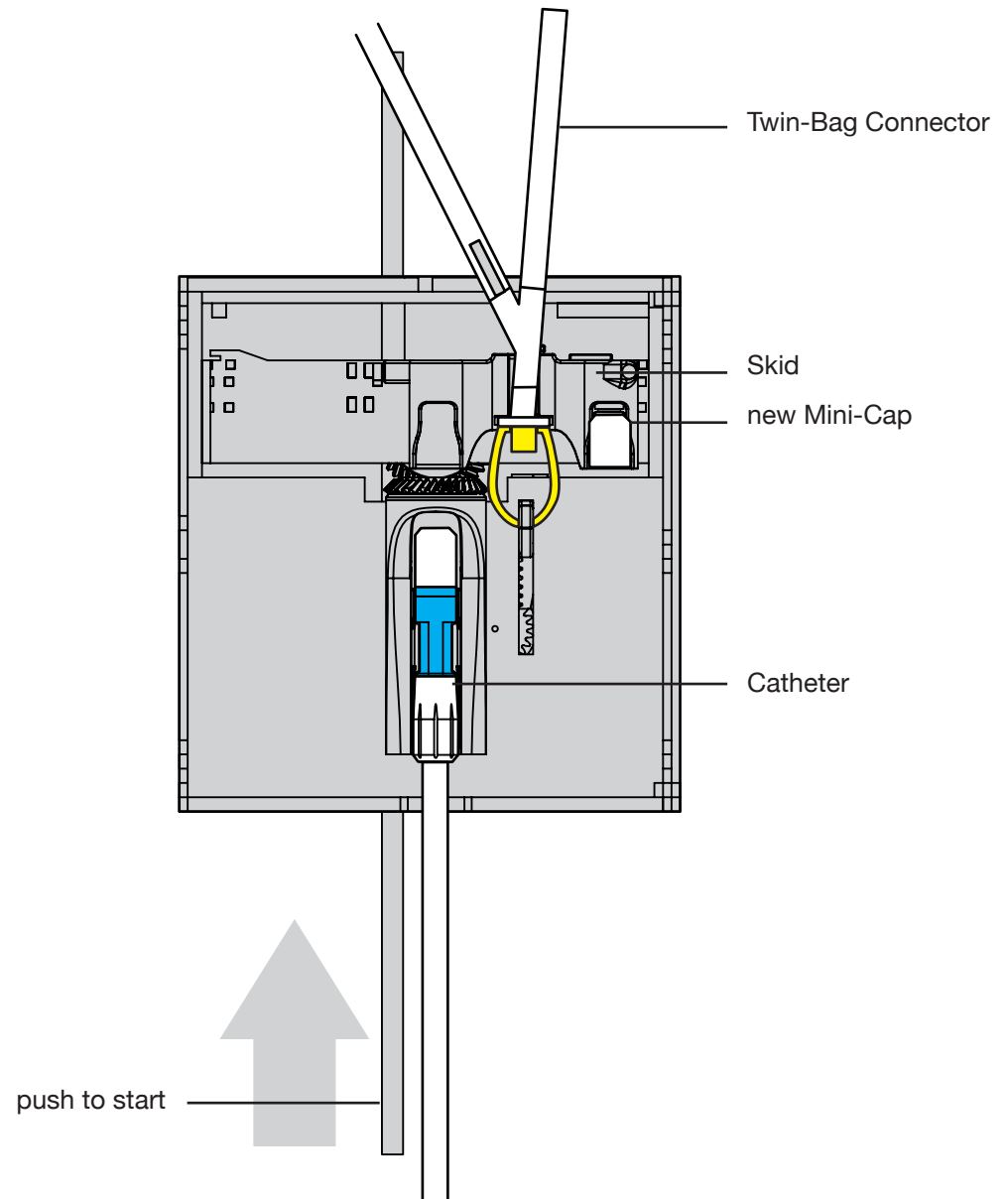
The other two pictures are design studies from industrial design students.



| **Design** |

Connector - Innovation ETH

The ETH is developing a new way to connect the catheter secure without infection to the Twin-Bag Connector and to the new Mini-Cap. The hole system works without electricity.



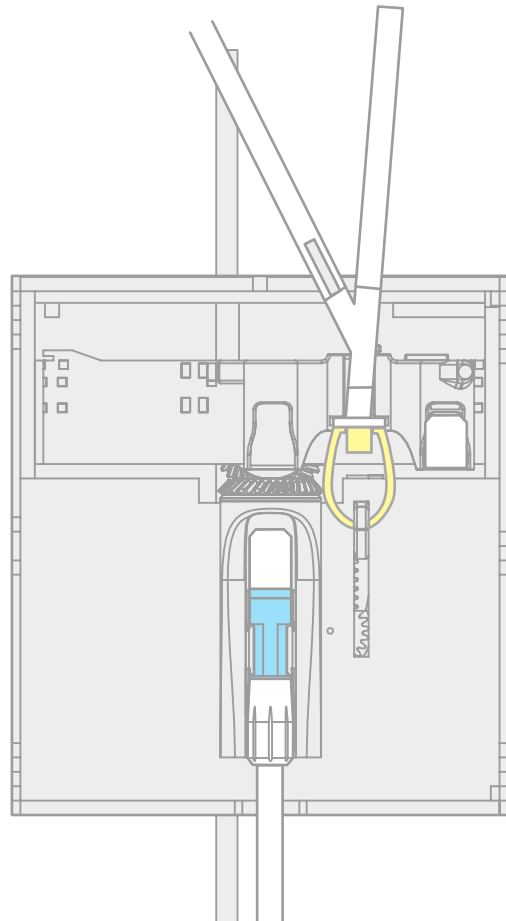
Usability

“open and read it like a book”

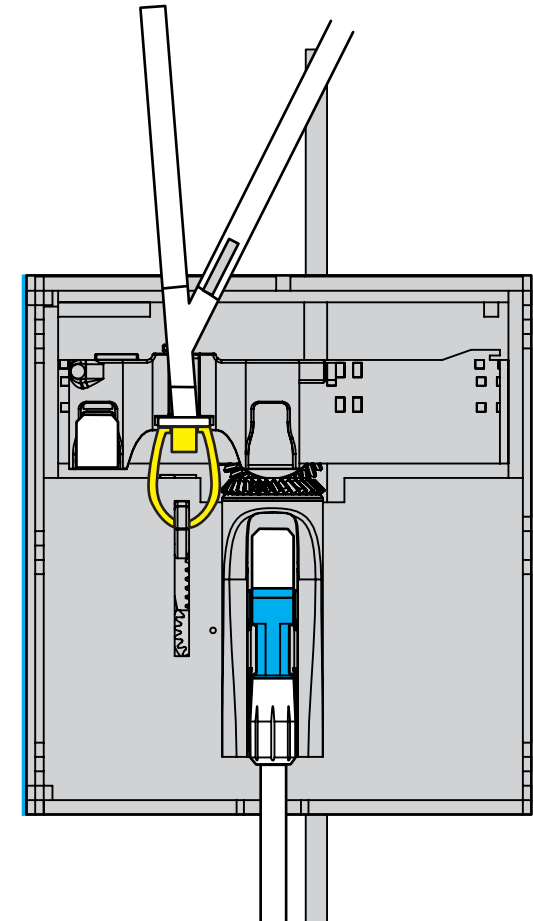
The original prototype of the ETH has the hinge on the right side and the cover gets opened from the left. People in the Western world are used to open covers like this from left side, as an example, a book gets opened from the left hand side. That is why the hinge's new position is on the left.

The skid in its initial position stays on the right side and moves during the treatment to the left. As with the cover, patients in the Western world are used to have the starting position on the left side and then moves on to the right (like reading text).

original prototyp

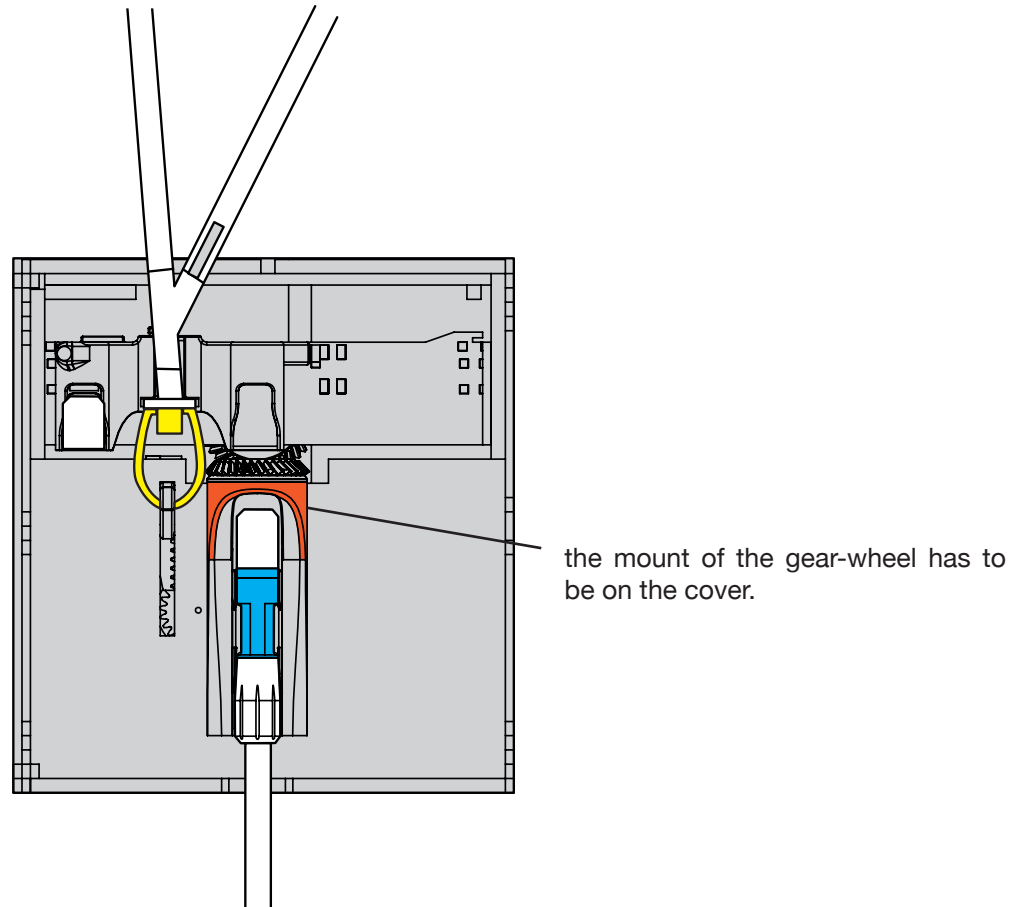


new prototyp



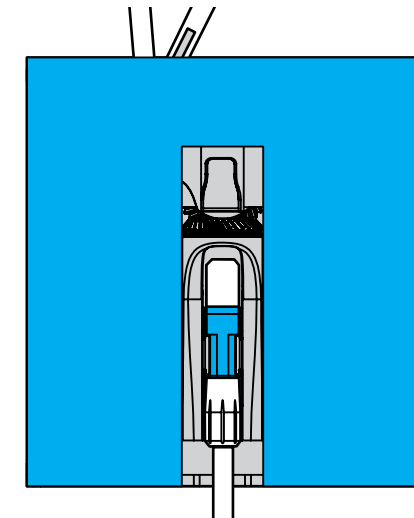
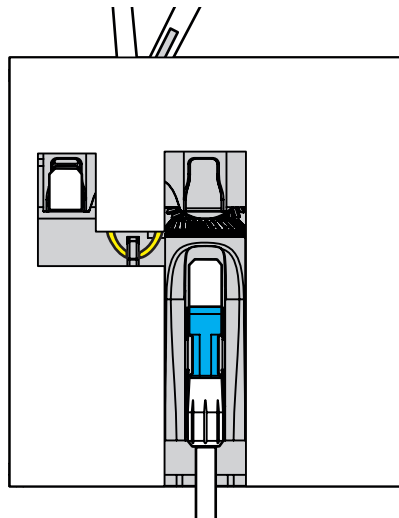
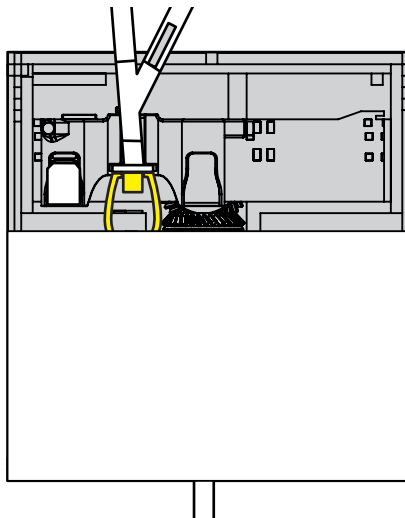
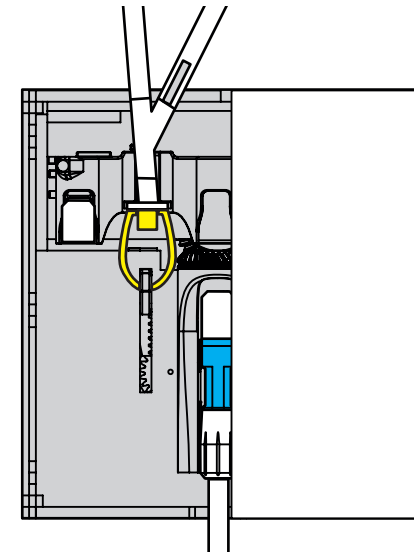
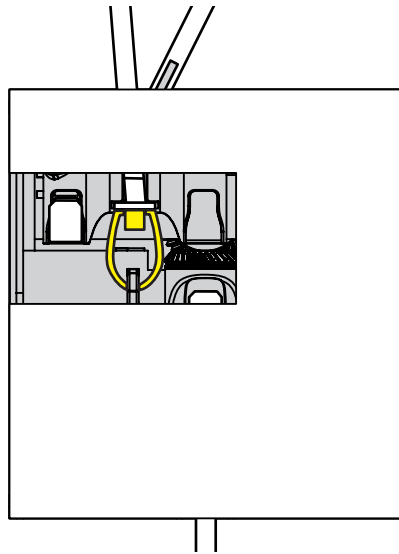
Connector - APD

The connector is thought of using it just for the CAPD. There would be a technical solution to allow APD patients to use the device as well.



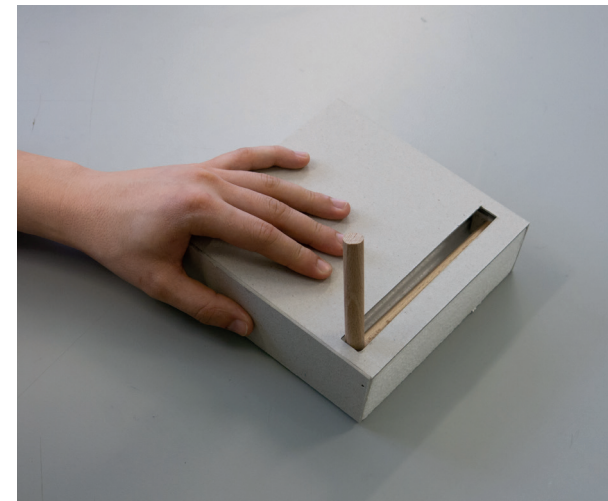
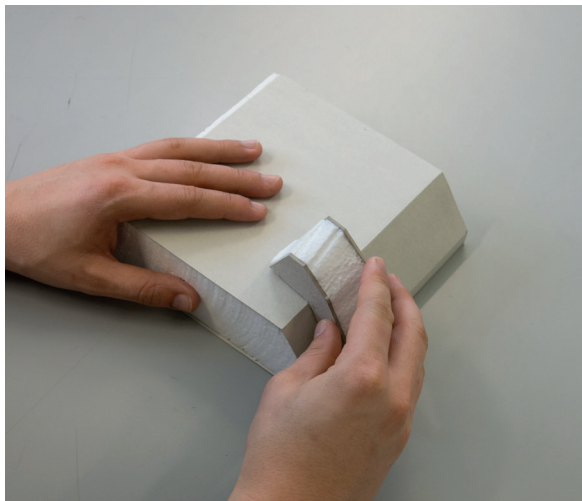
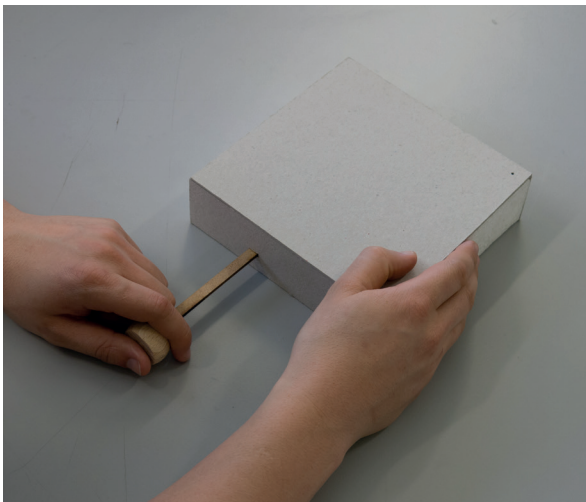
Usability Feedback

The patient does not have to see every detail of the mechanical parts. There is the chance of confusion. A slight window is enough to see what is going on. Apart from this, it is easier to have not just a visual feedback. If the patient has implemented all the things in the right spot. A mechanical feedback is more user friendly. For example, when the new mini-cap is not in the place inside, the treatment cannot begin. The patient has to open the cover again and implement the mini-cap in the right spot.

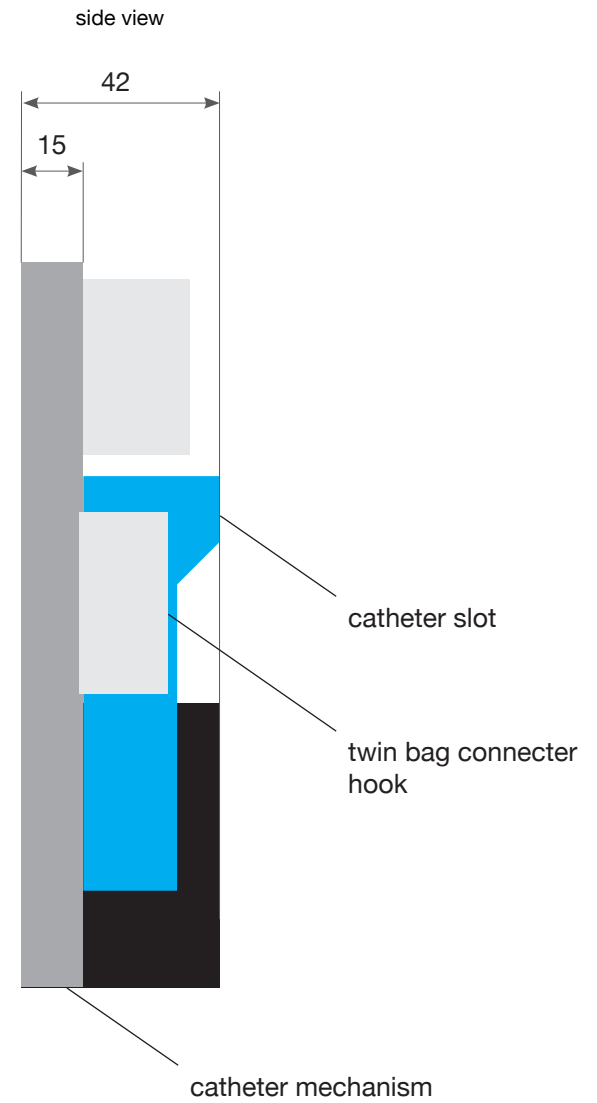
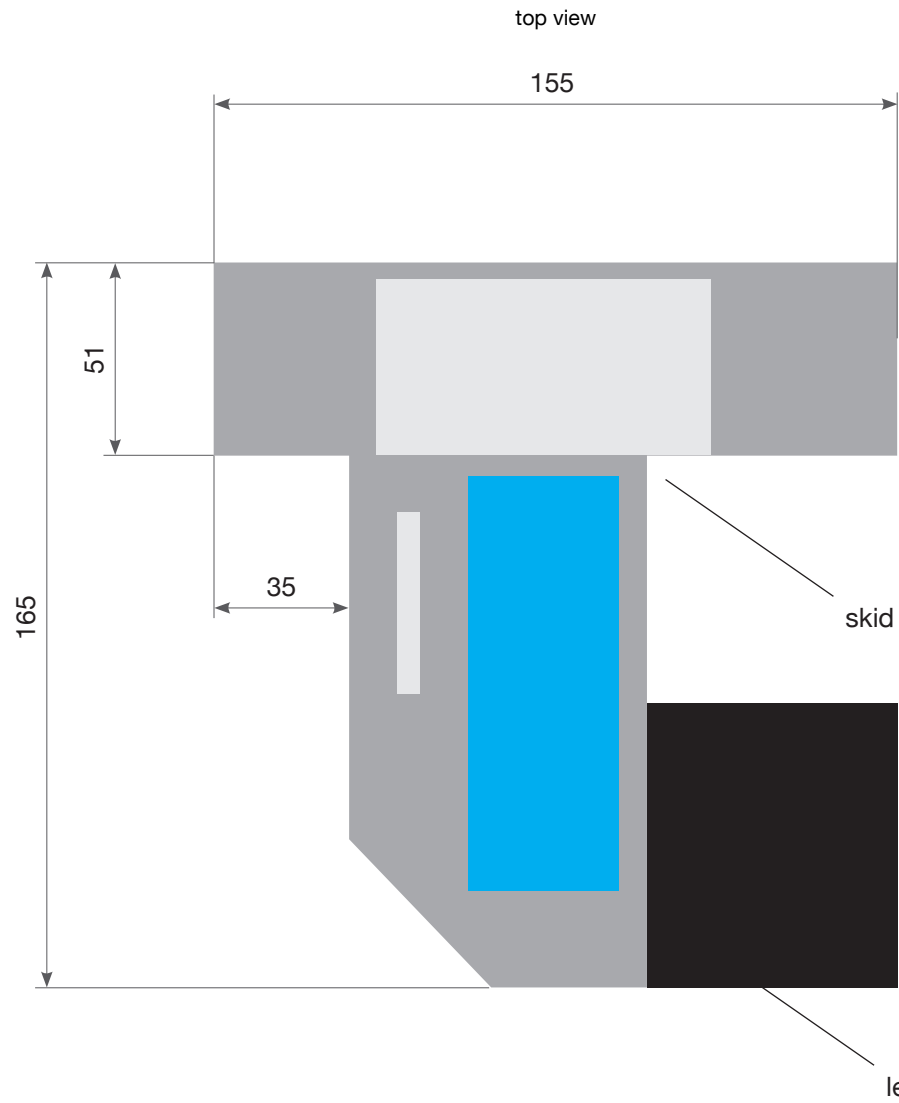


Connector - Usability lever

The original mechanism to actuate and control the treatment is a gear rack (picture bellow). This gear rack is on the same spot as the catheter gets placed. For patients, the catheter exit on the skin is a very sensitive spot, and with the gear rack in this position, it is supposable that the rack and the catheter get in each others way. As testing different prototypes with proband showed, allmost all felt more comfortable with a casual lever (picture on the right).



Space Requirements



Patients Voice

Throughout my theoretical Bachelor Thesis I gained some interviews with patients that treat themselves at home. This is their opinion how a home medical care product should look like:

„A more elegant design..“

Bernard Snajder, 34, kidney patient, APD

„It should not show that it is a medical device. For many people that is a problem and they are hiding their things.“

Peter Studer, 54, chronic obstructive lung disease patient

„It would be nice if the object would be more appealing to the patient.

A different color would change much. A soft yellow or a lime green would give more warmth“

Ursula Griner, 63, chronic obstructive lung disease patient

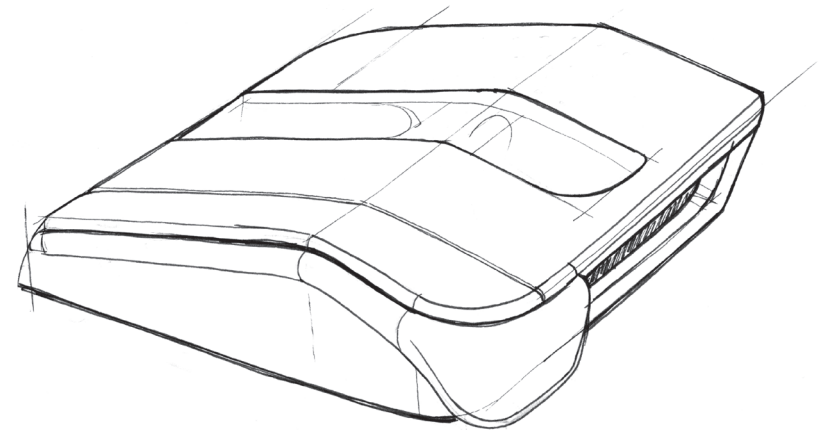
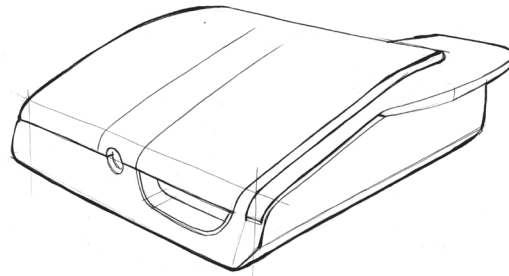
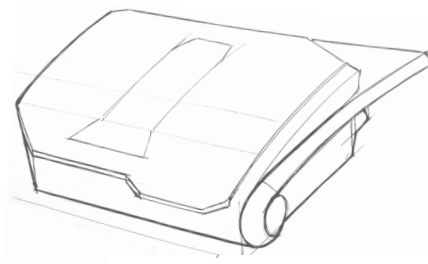
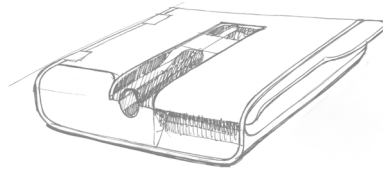
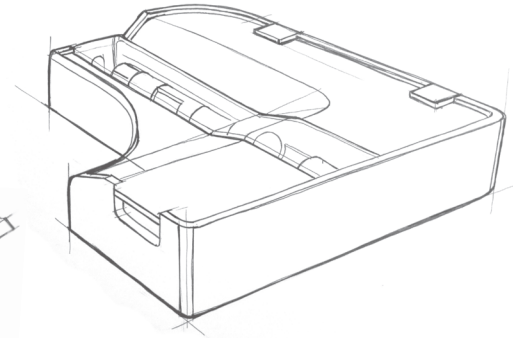
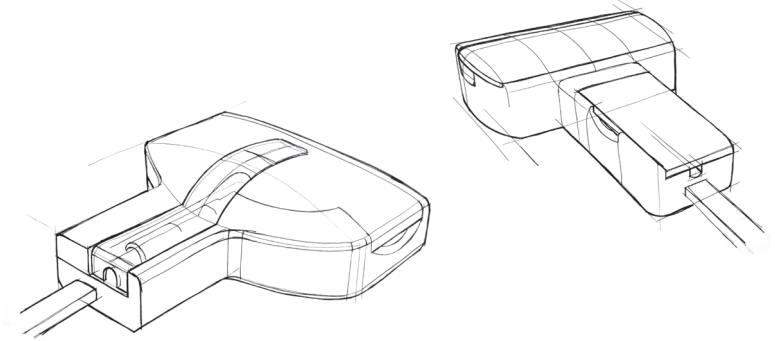
Moodboard

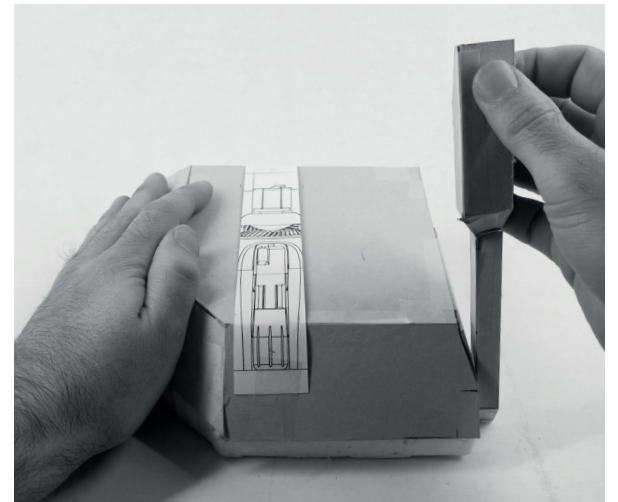
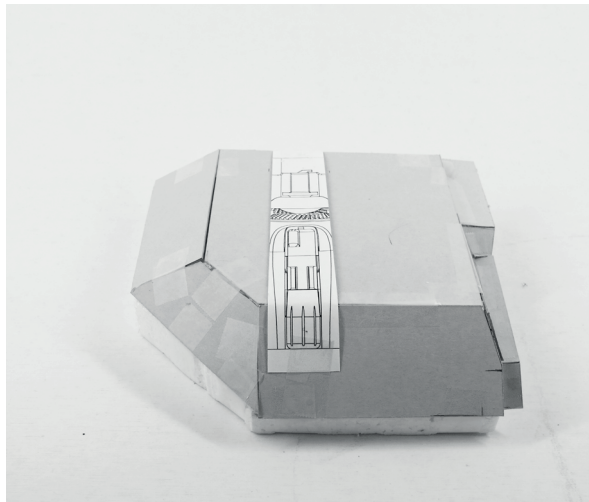
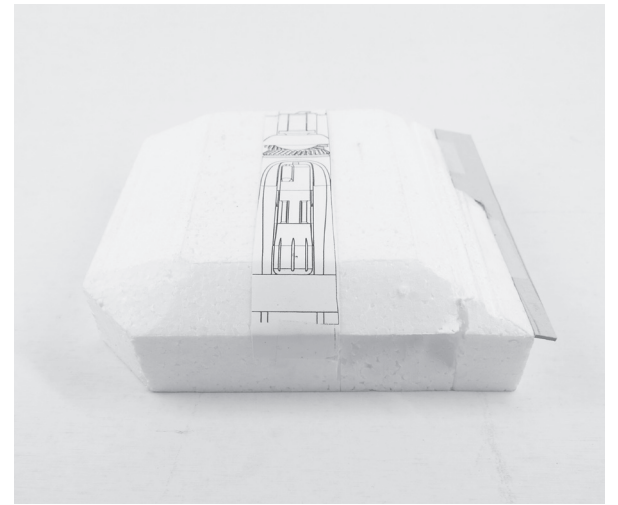
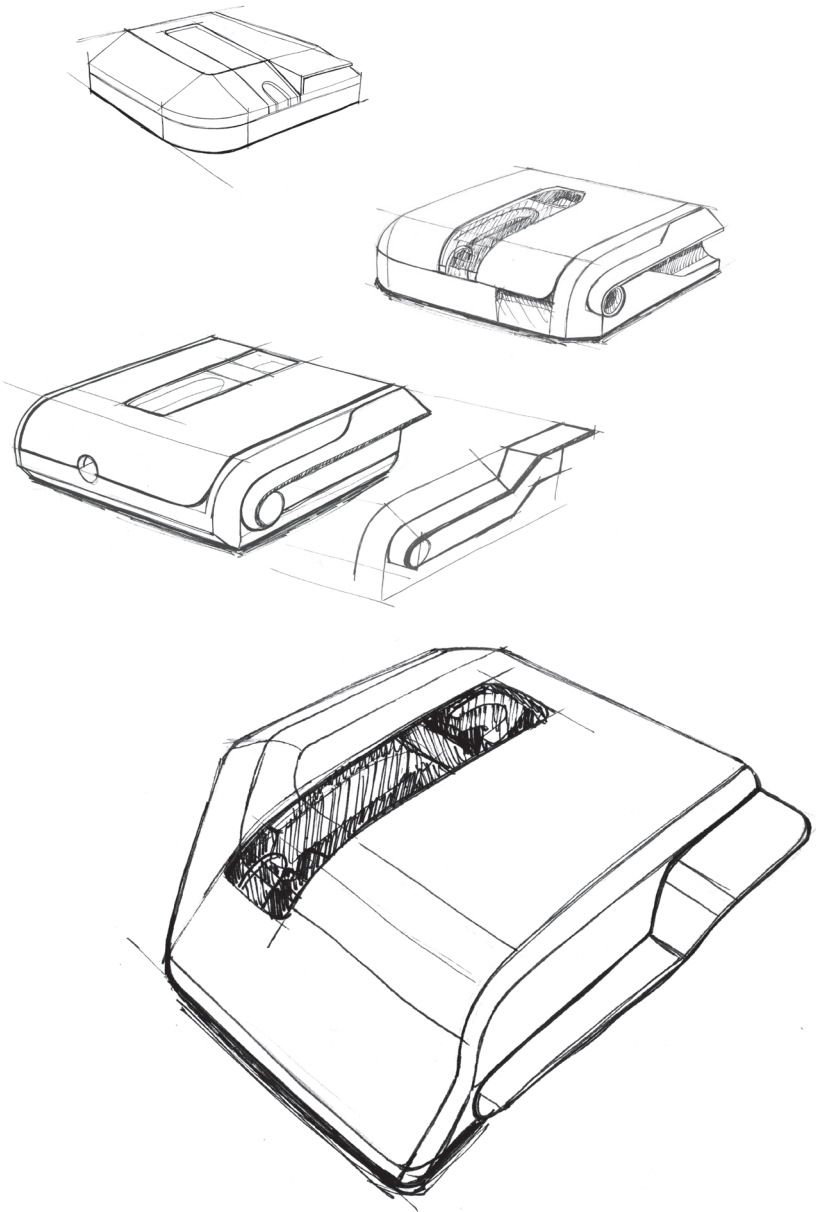


trustworthy
calm
unremarkable

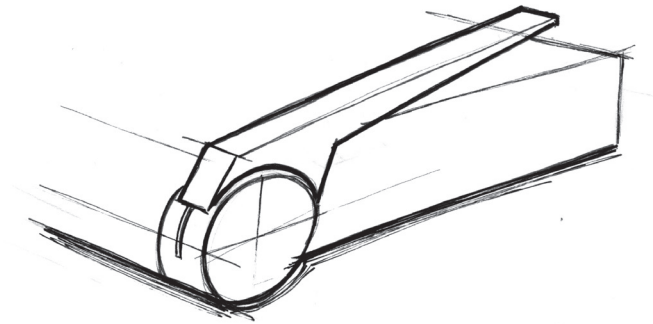
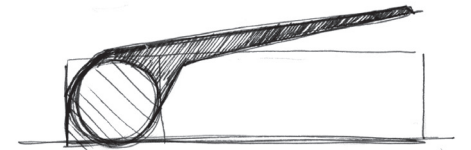
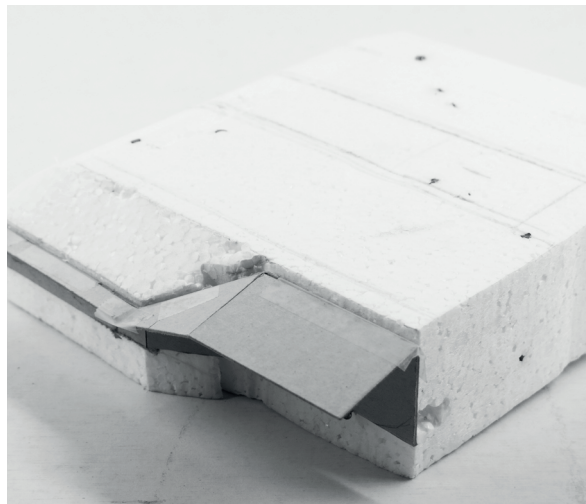
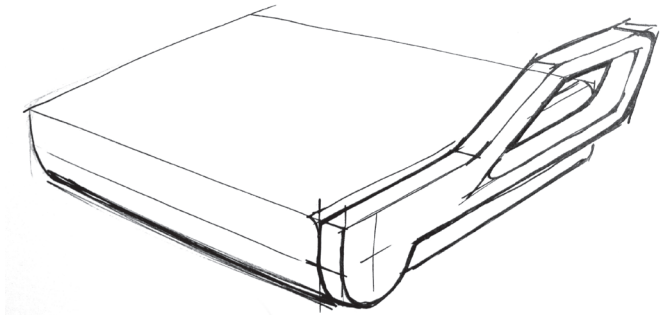
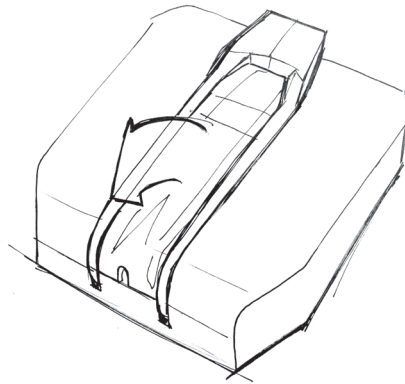


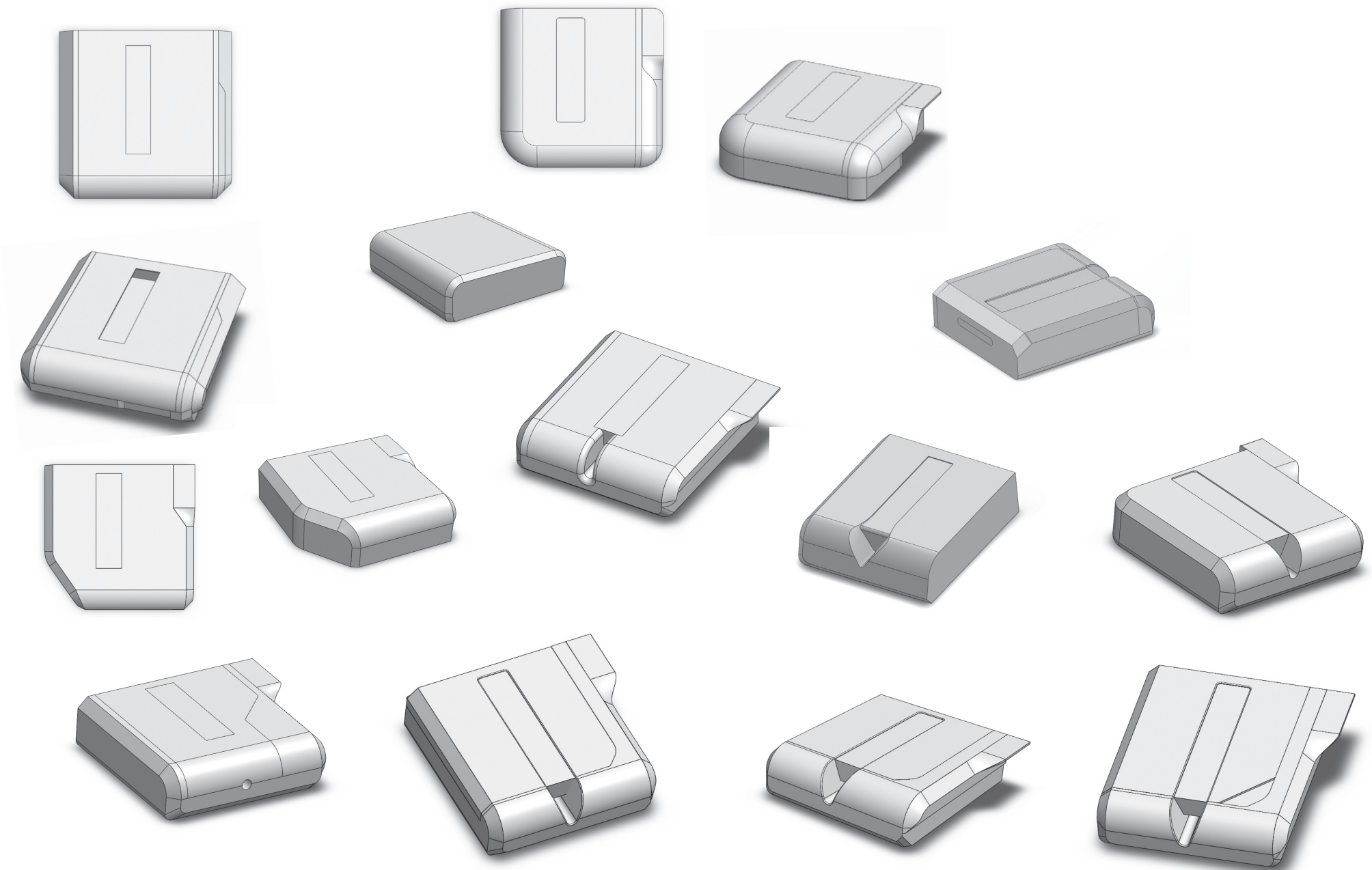
Connector - Design





Connector - Design

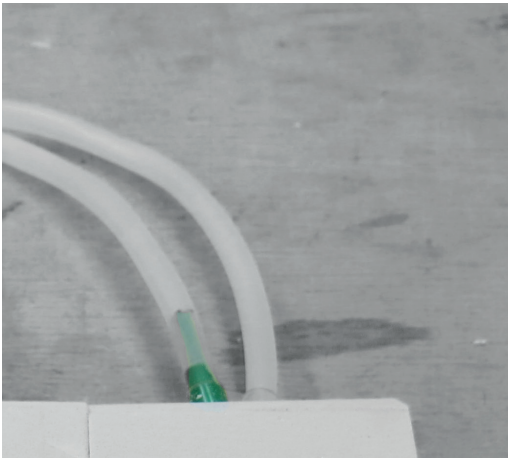




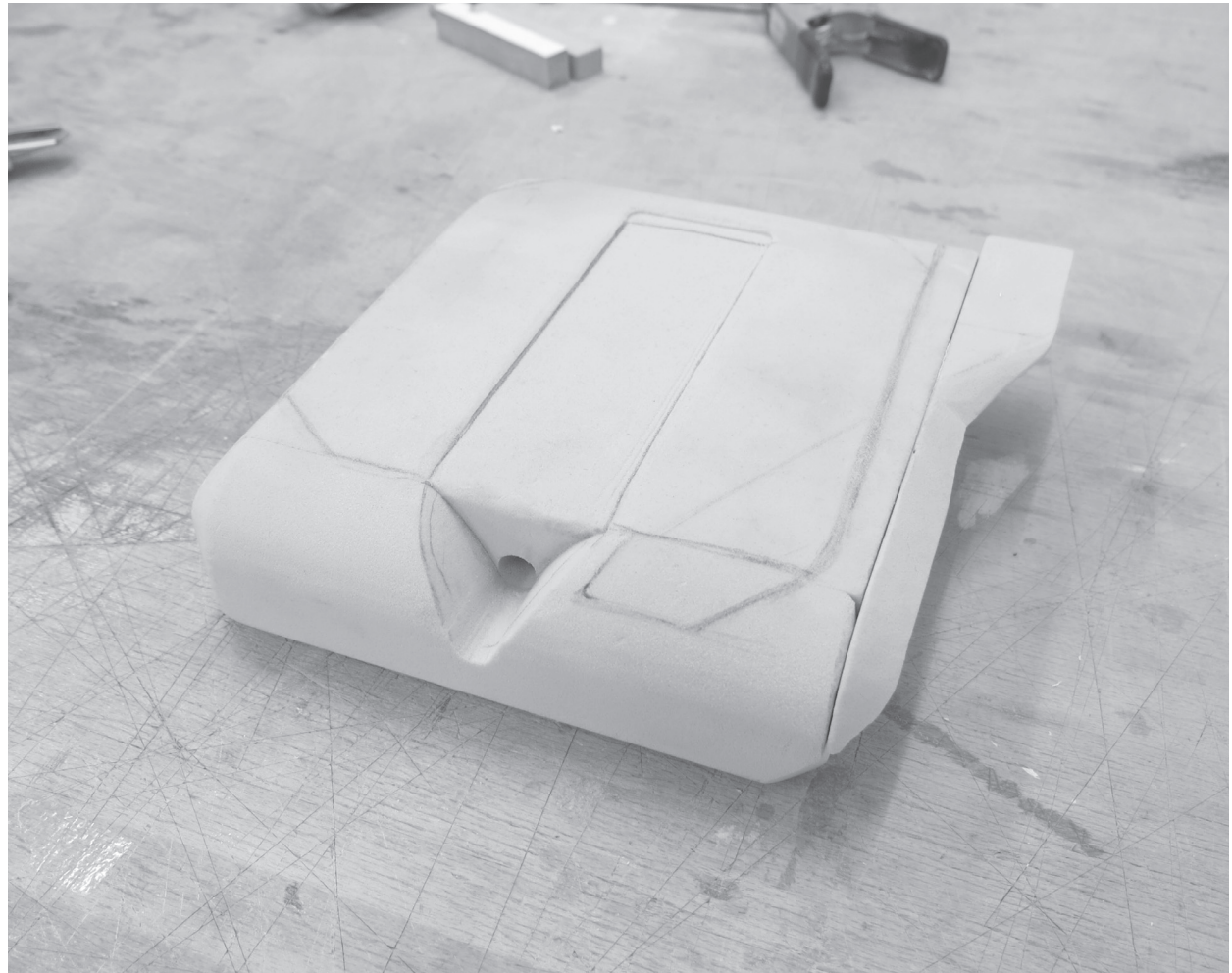
Connector - Design

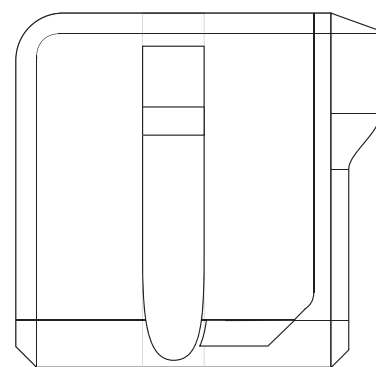
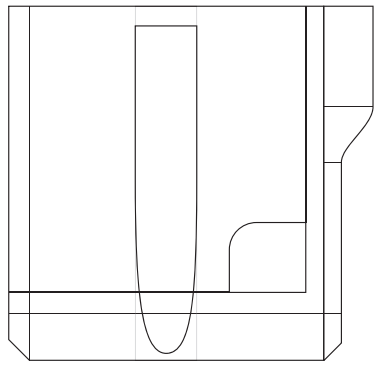
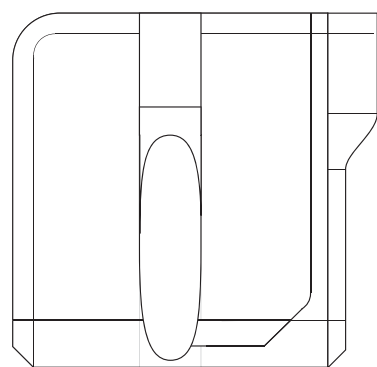
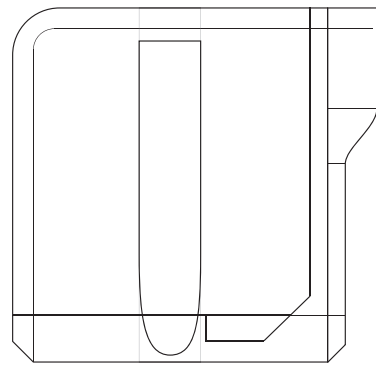
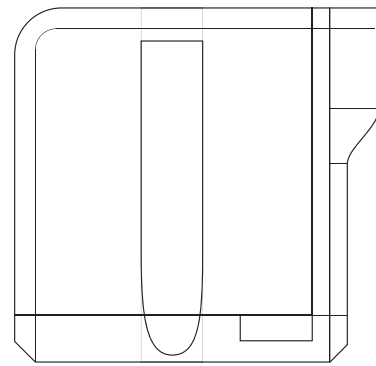
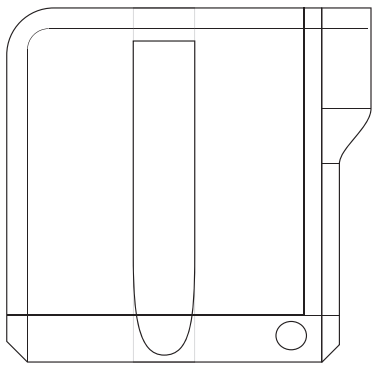
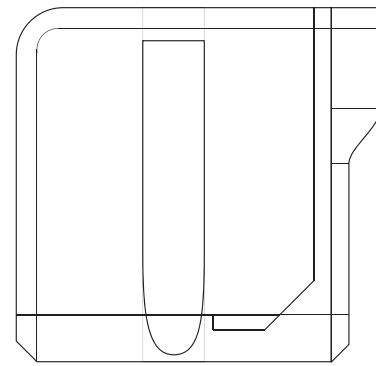
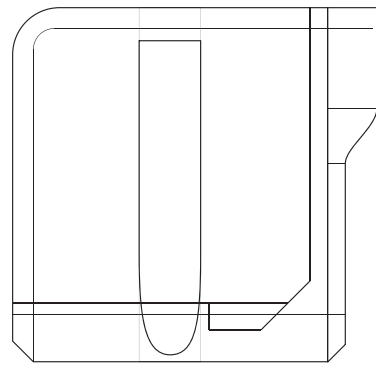
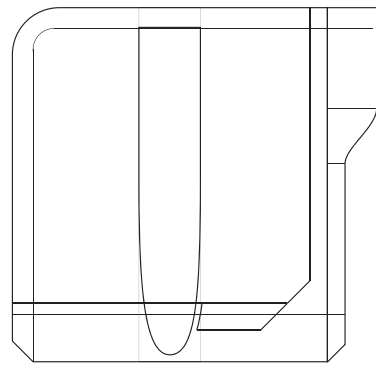
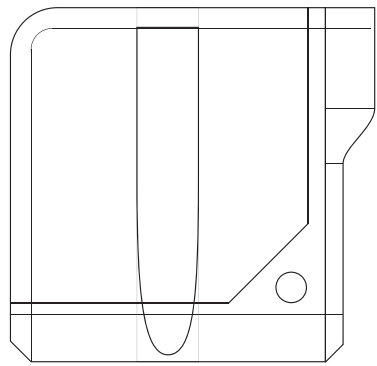
The chamfer on the back side of the device is important to see the green seal.

with chamfer



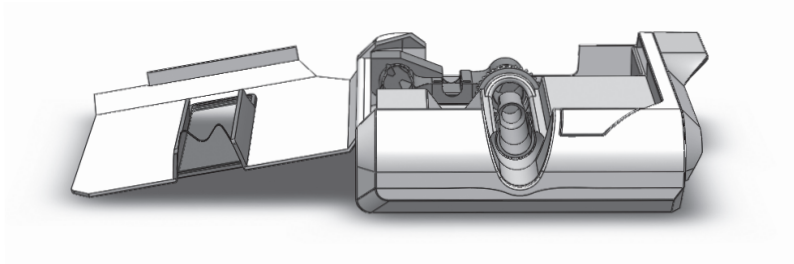
without chamfer



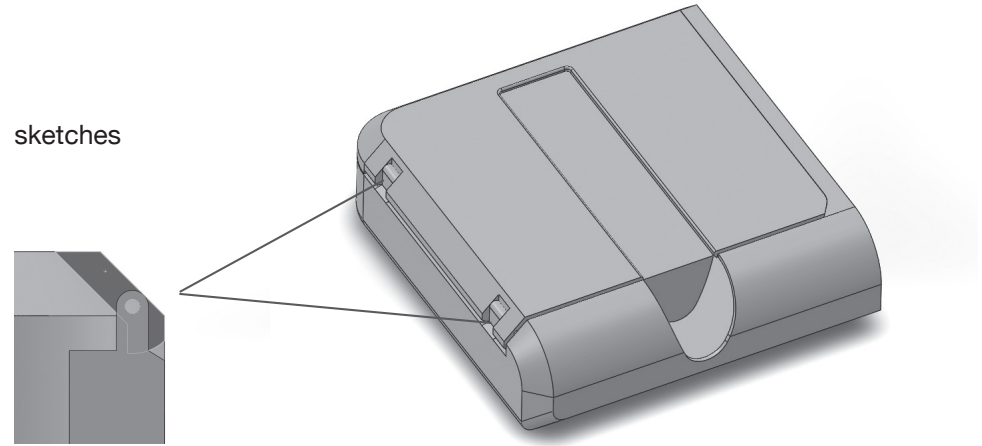


Connector Hinge

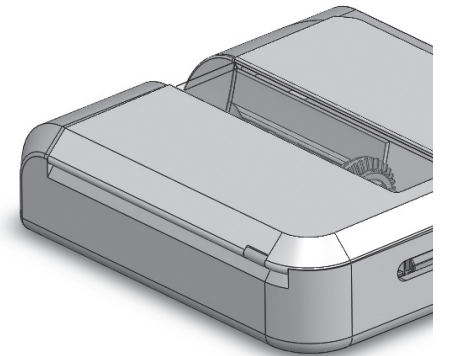
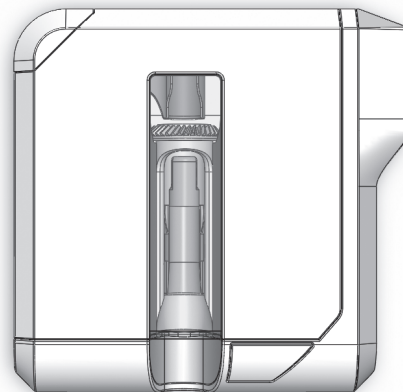
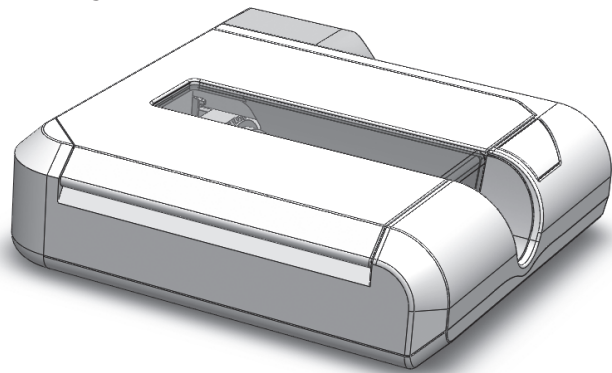
It is very important that the patient can open the top over 180° to the bottom. It allows a comfortable loading of the items.

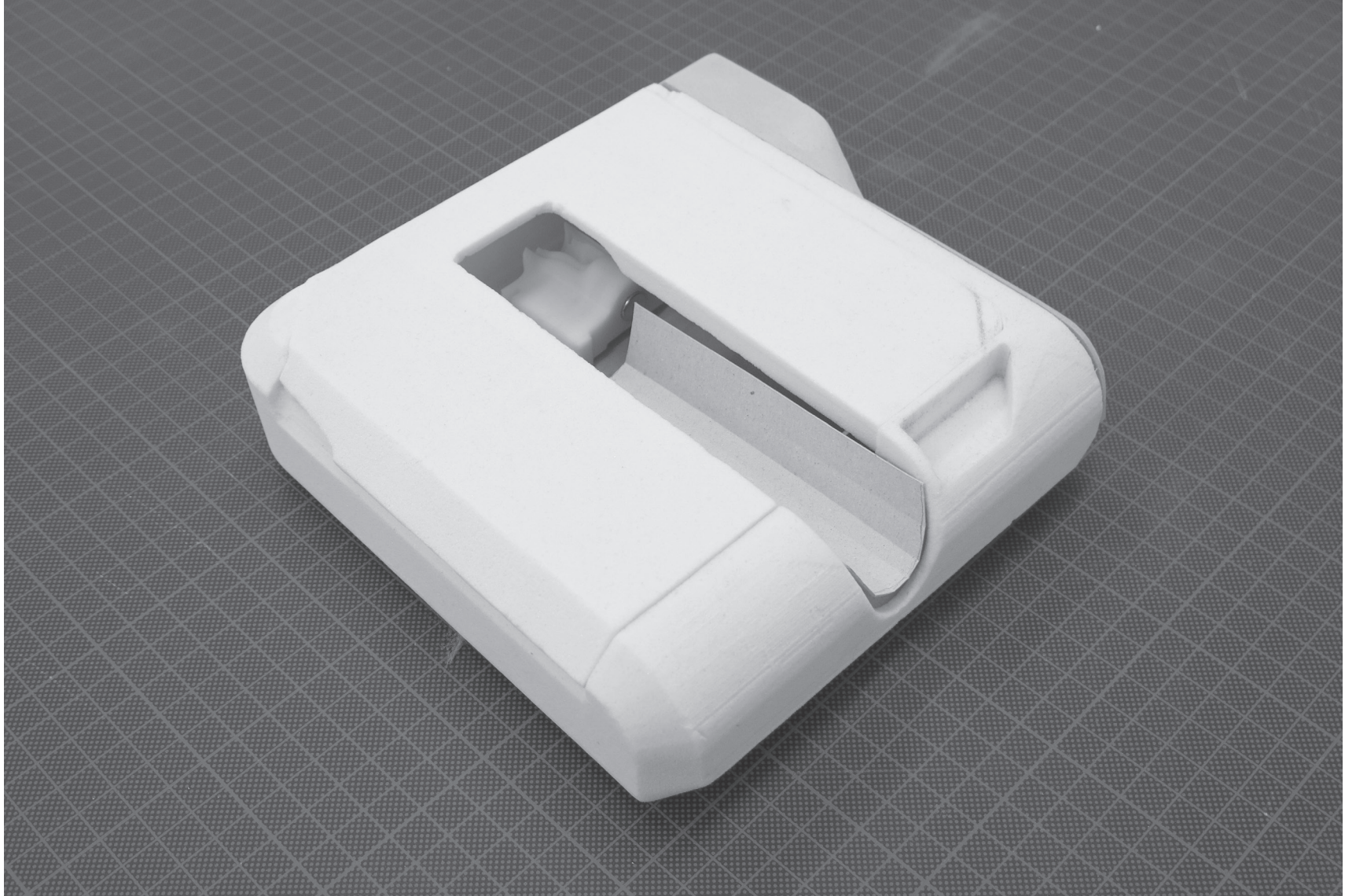


sketches

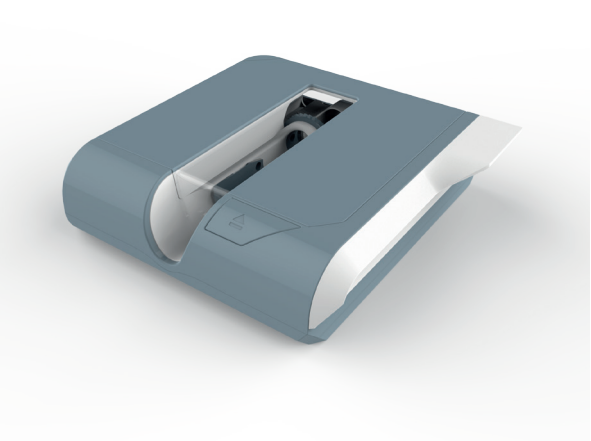
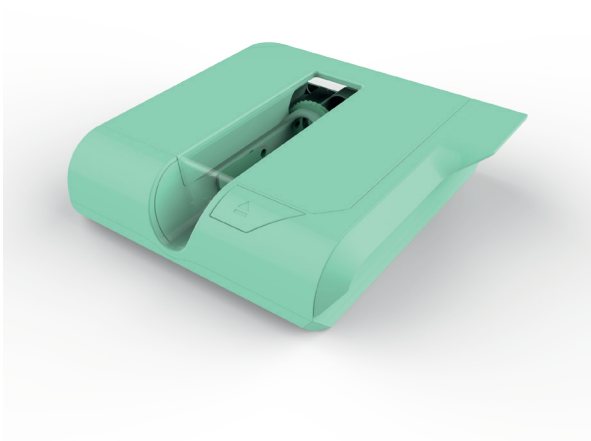
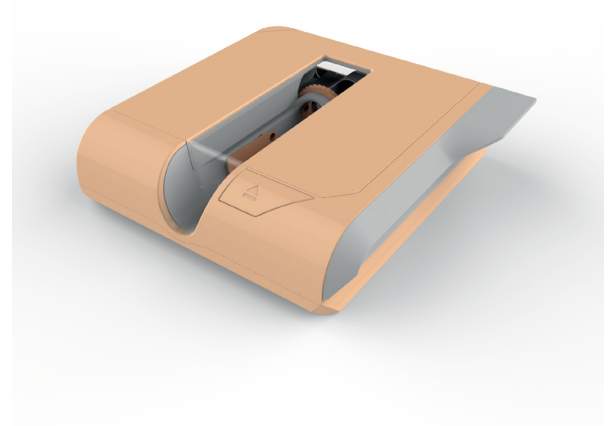
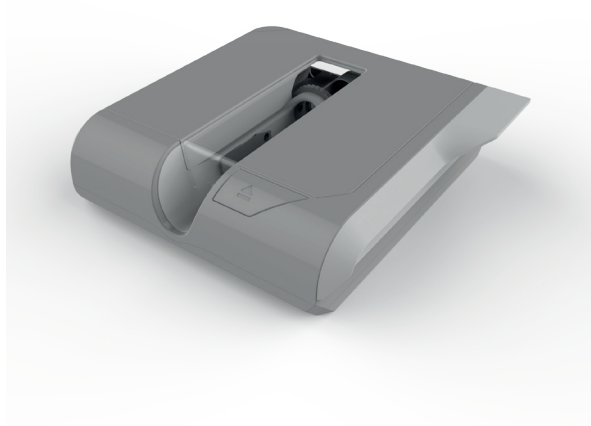


actual hinge



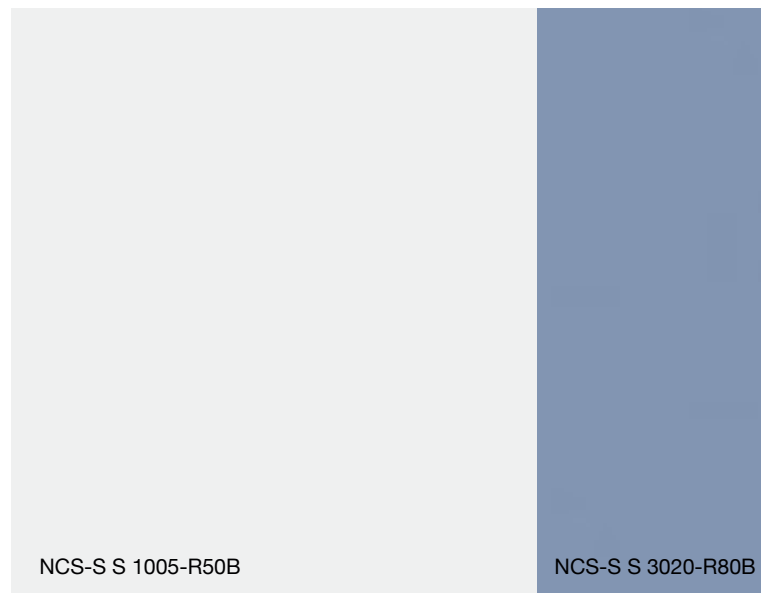
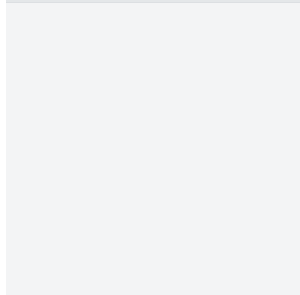
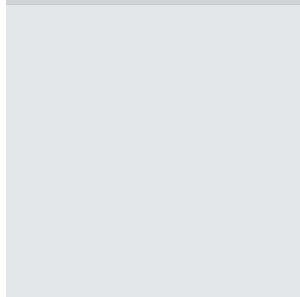
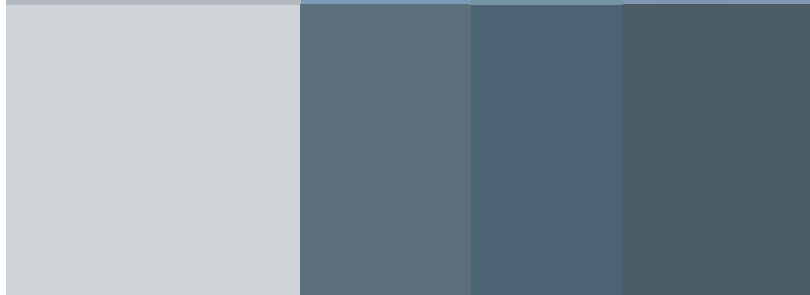
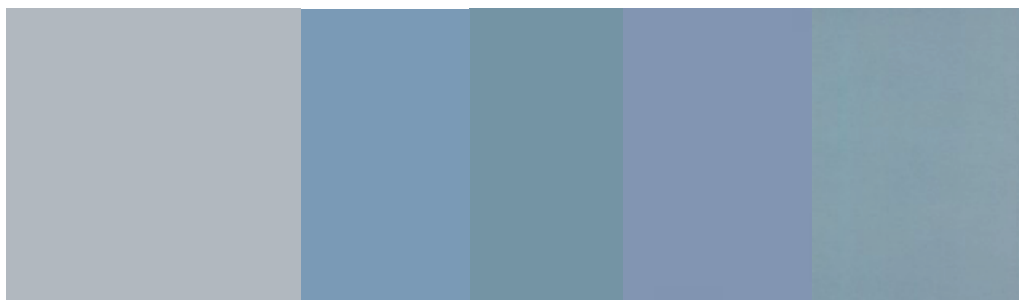


| Color |





| Color |



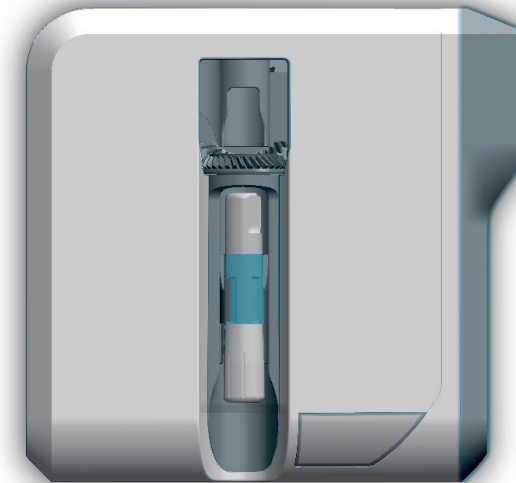
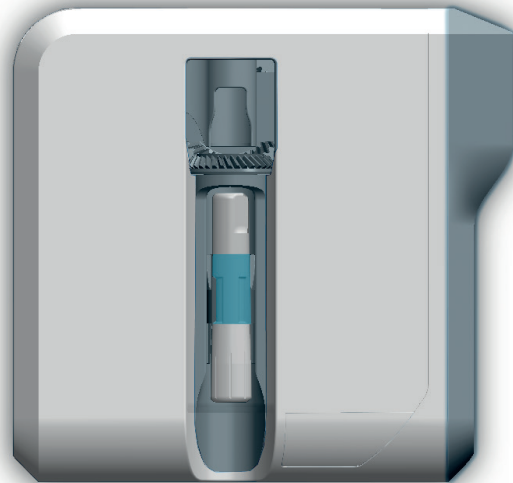
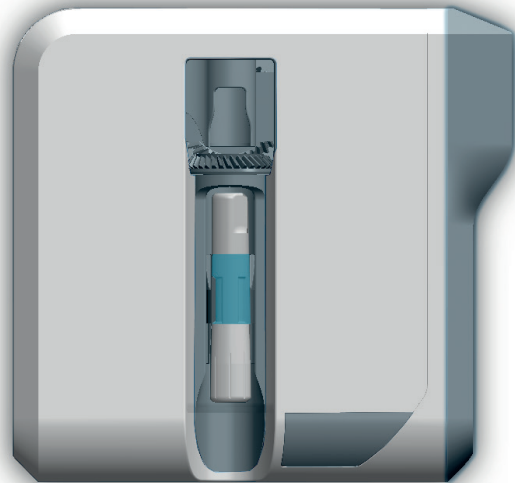
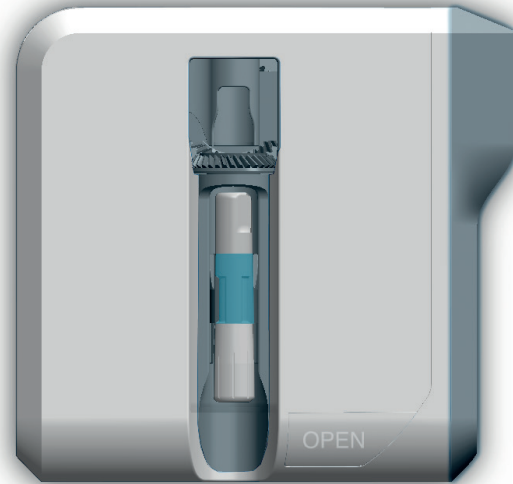
NCS-S S 1005-R50B

NCS-S S 3020-R80B

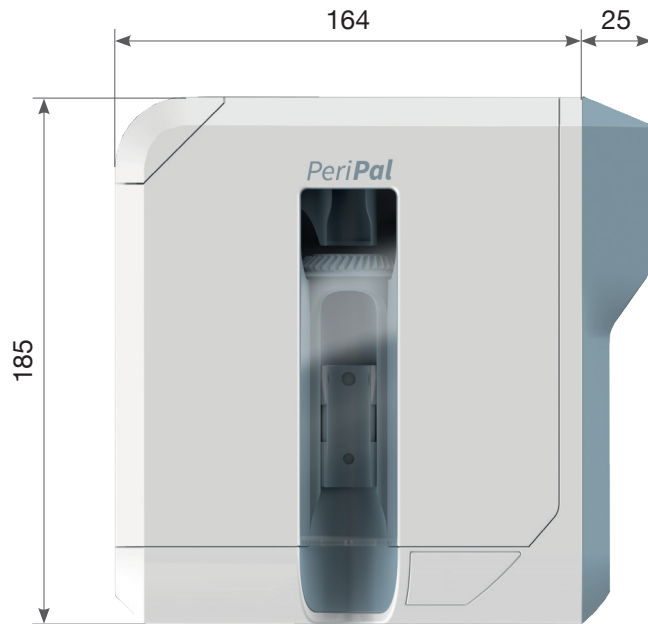
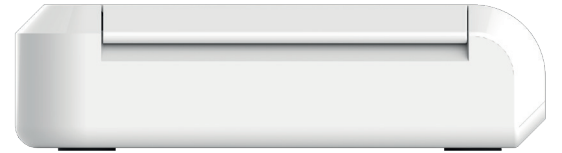
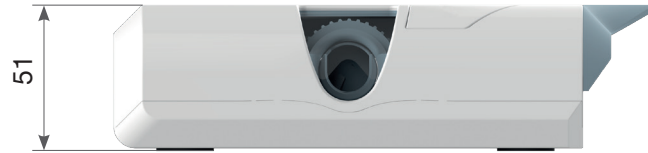
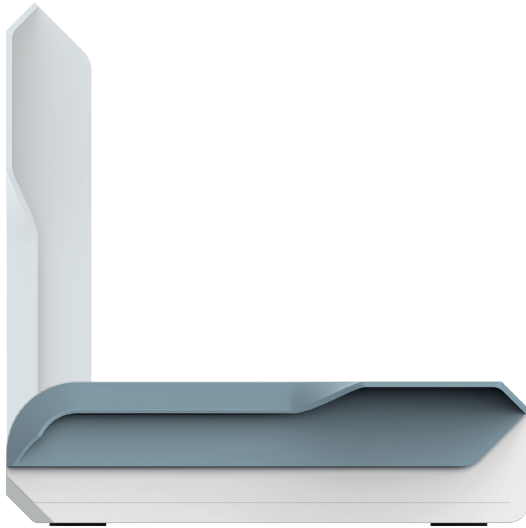


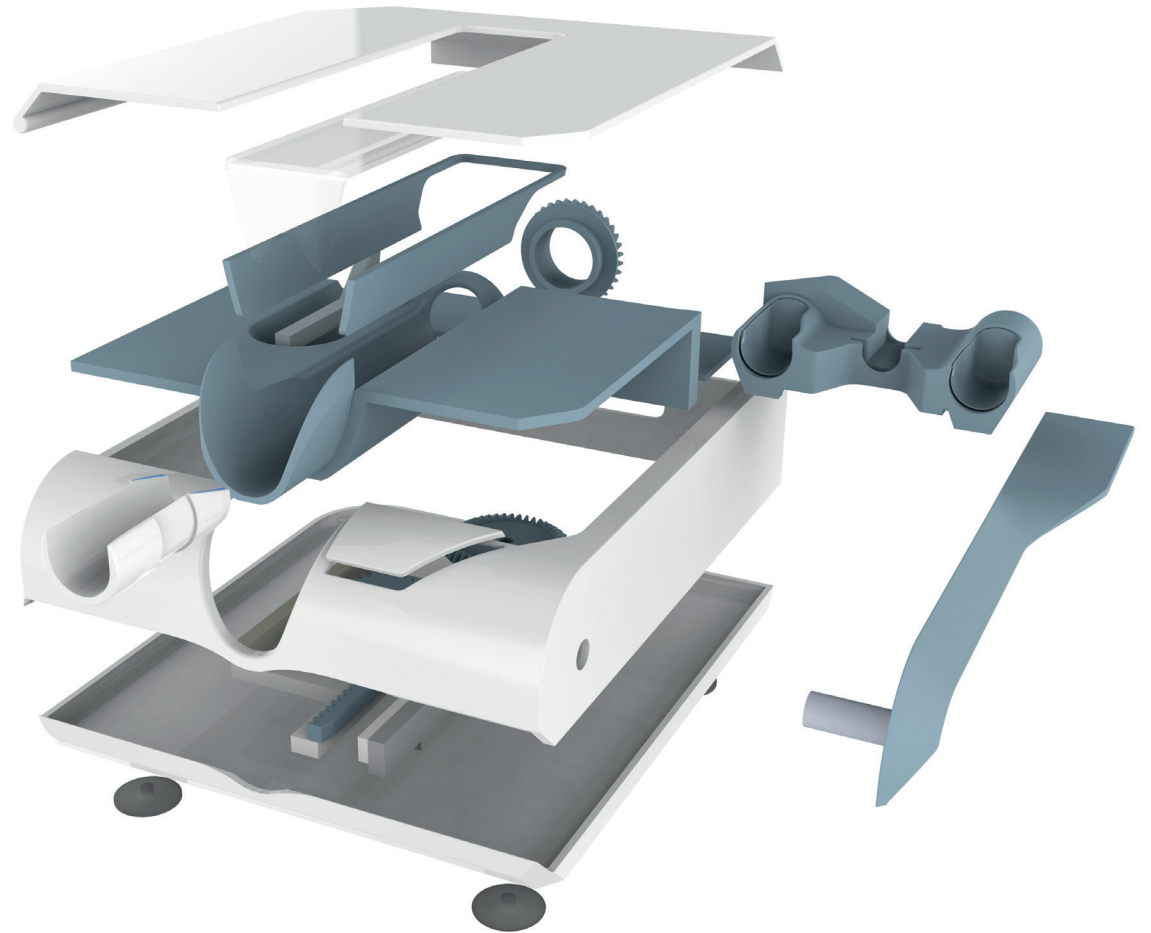
Button Design

The top gets opened by pushing the „open“ button. A torsion spring in the hinge lifts the top about 4cm over the body part level. This kind of action is clear and simple. The top does not get damaged by pulling the cover accidentally in the wrong moment.



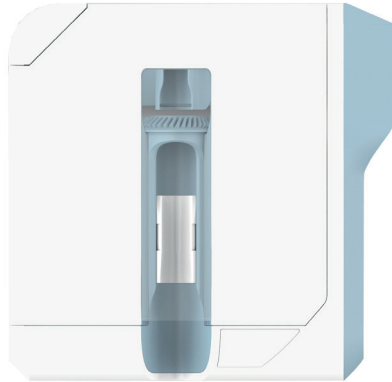
Connector - Final Design



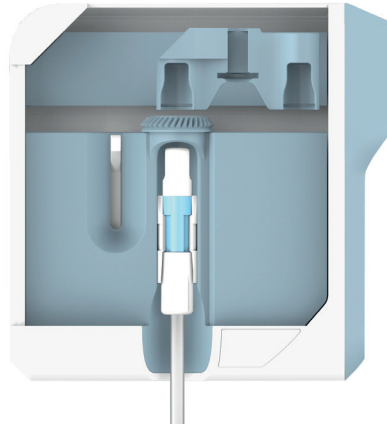


Connector - Treatment Cycle

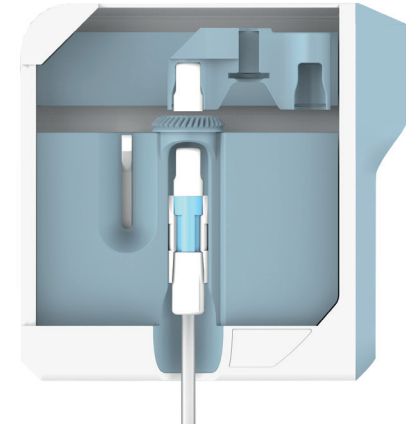
1. push the button to open the top



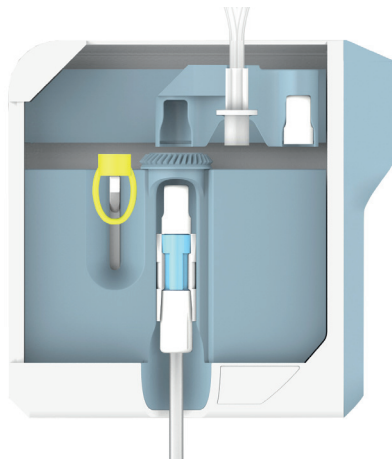
2. insert the Catheter



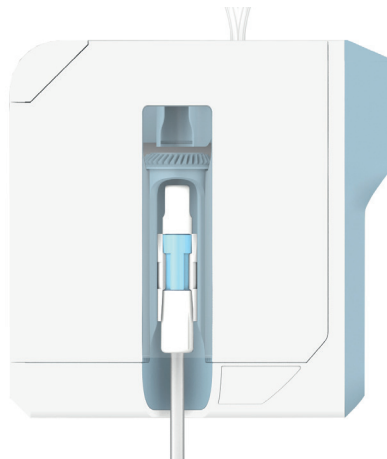
3. insert the new Mini-Cap



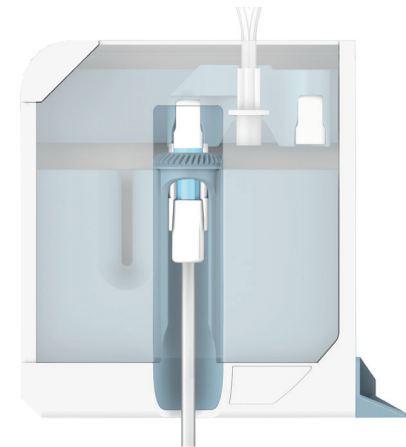
12. push the the button and remove the items



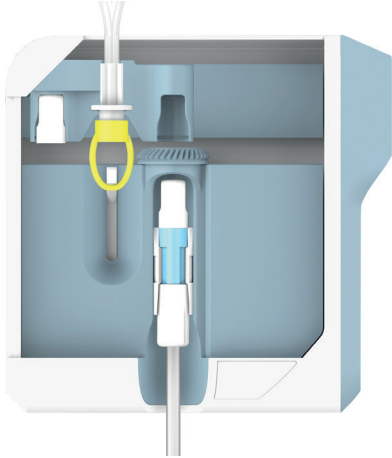
11. push the lever and the top is cleared



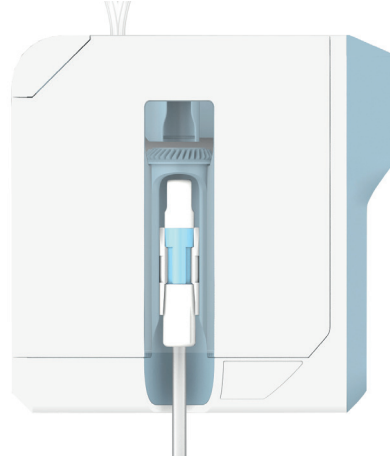
10. pull the lever



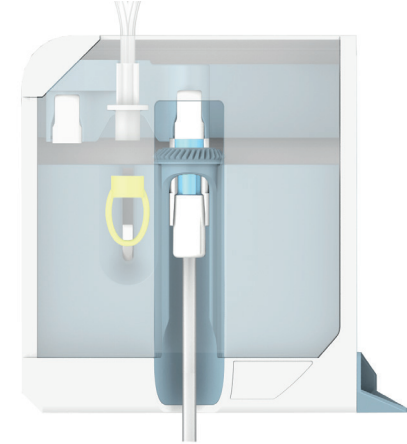
4. slide the skid and insert the twin-bag connector on the hook.



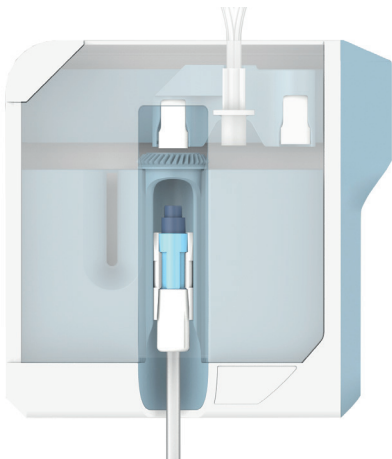
5. close the top



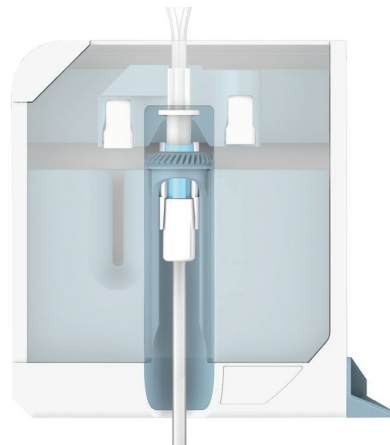
6. pull the lever



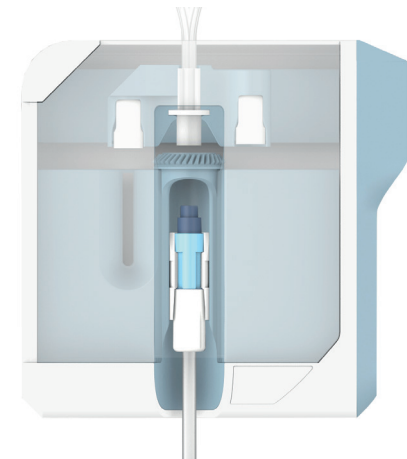
9. push the level to finish the treatment



8. pull the lever again and the treatment can start



7. push the lever



Heating Bag - Concept

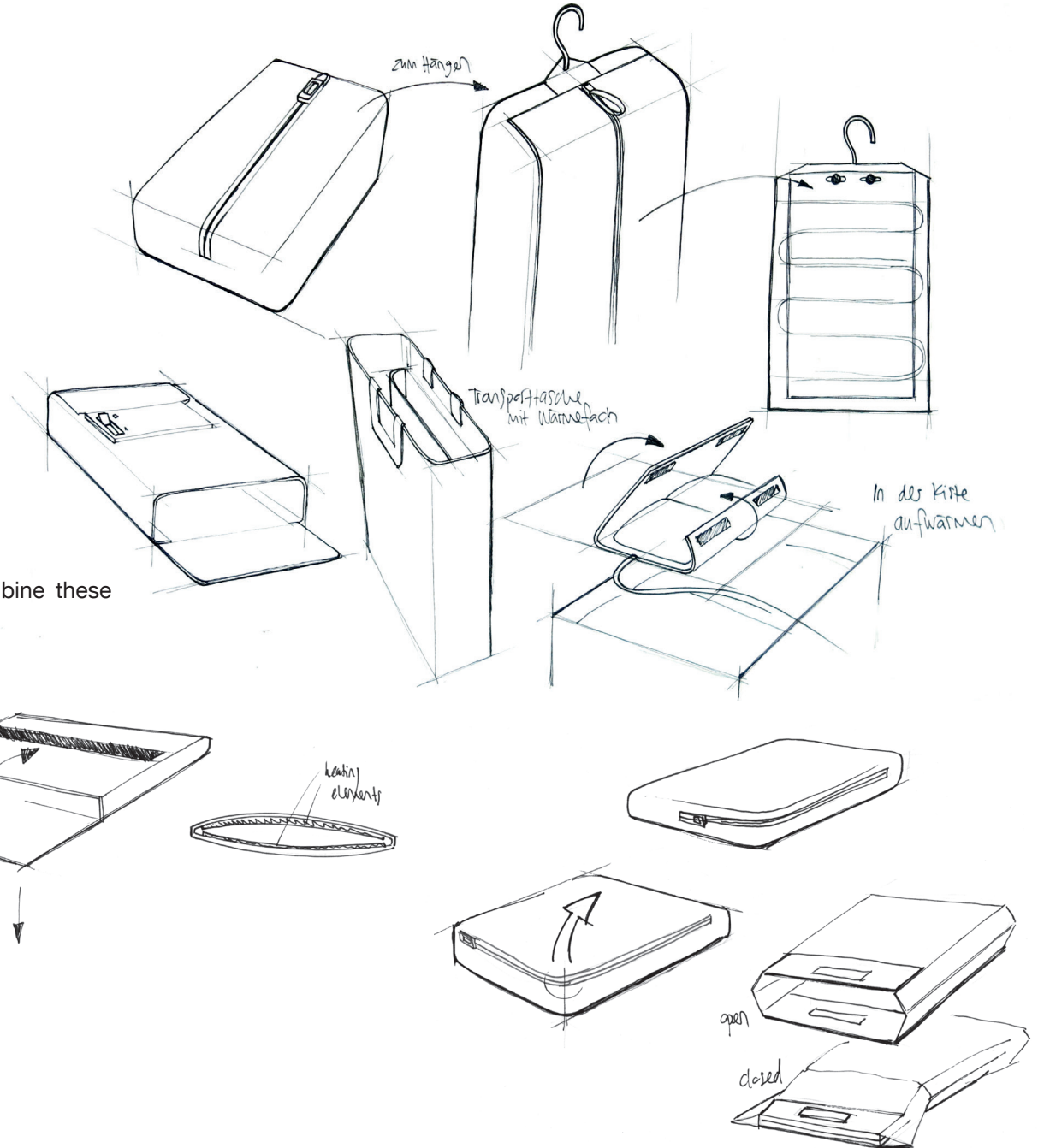
solution warmer for traveling



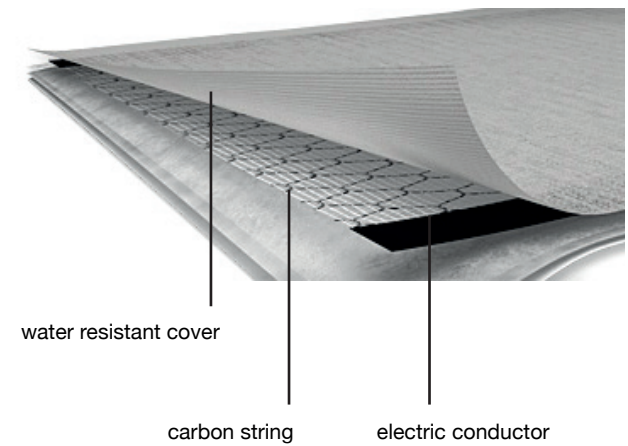
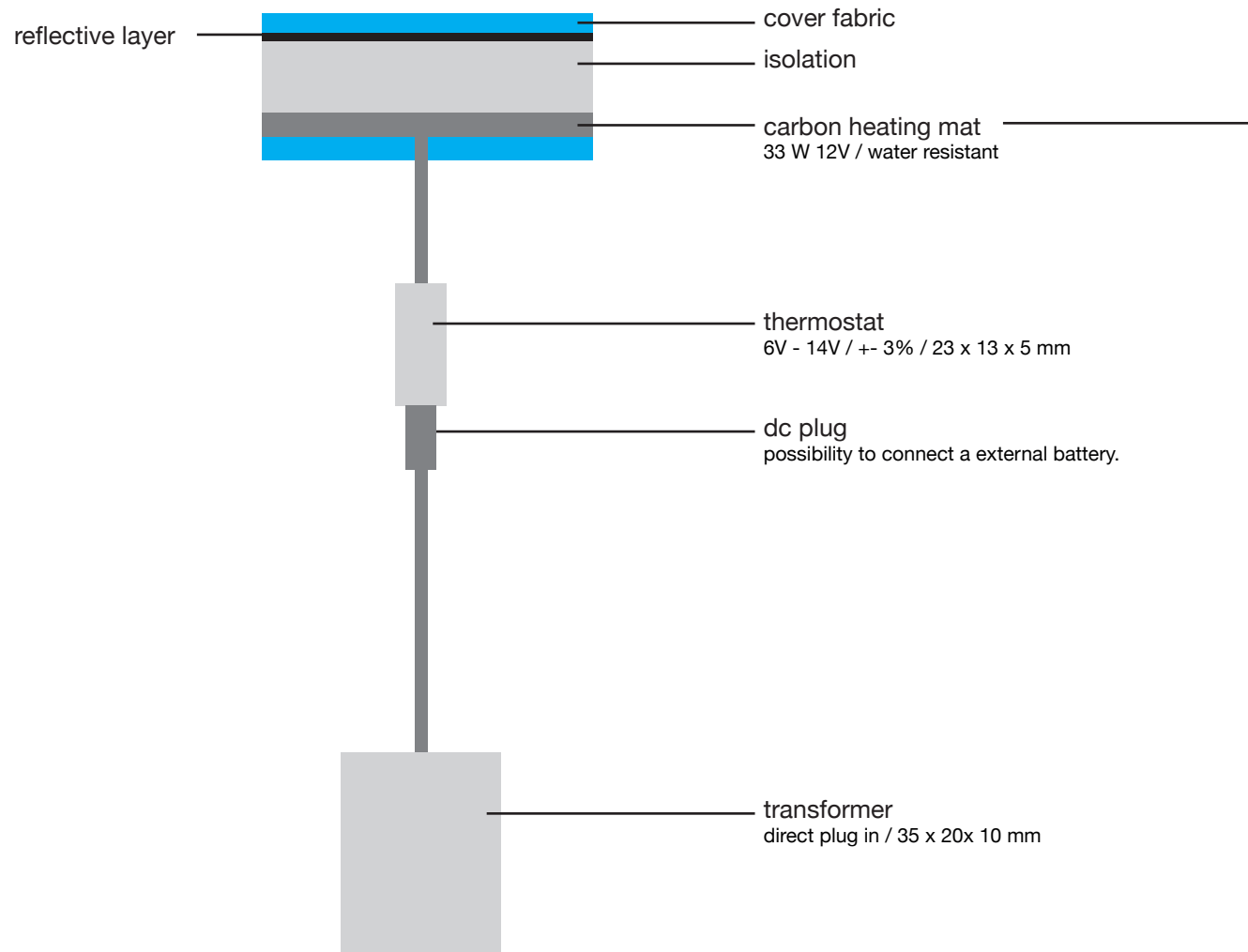
solution warmer for home-use



My aim is to combine these products into one.



Technology

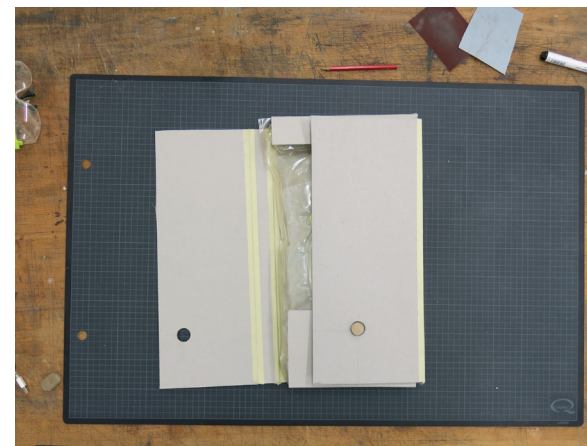


Heating Bag - Prototypes

„fishernet“



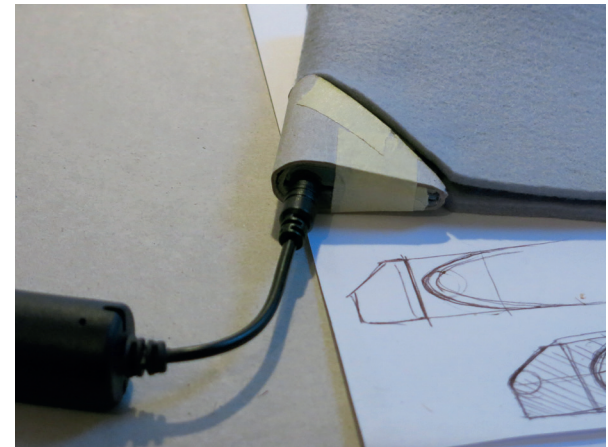
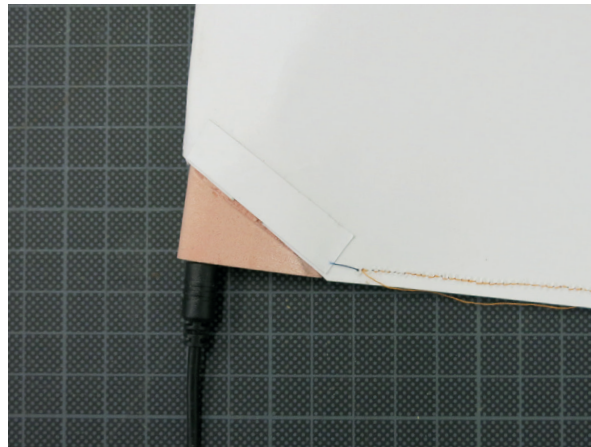
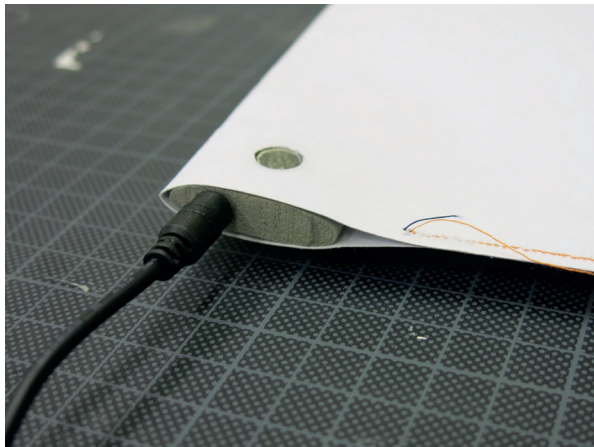
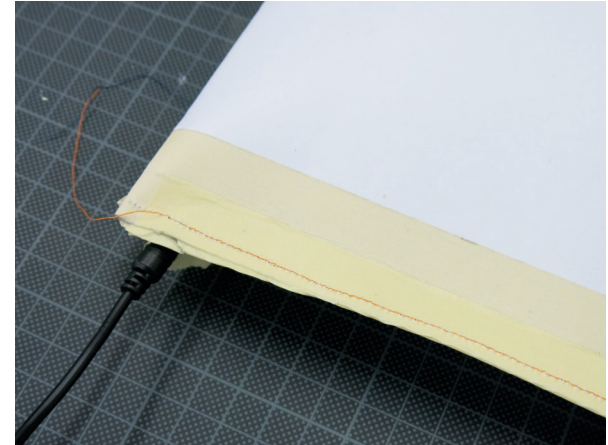
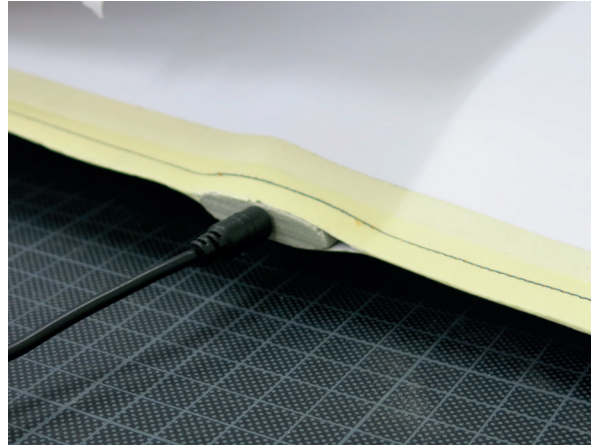
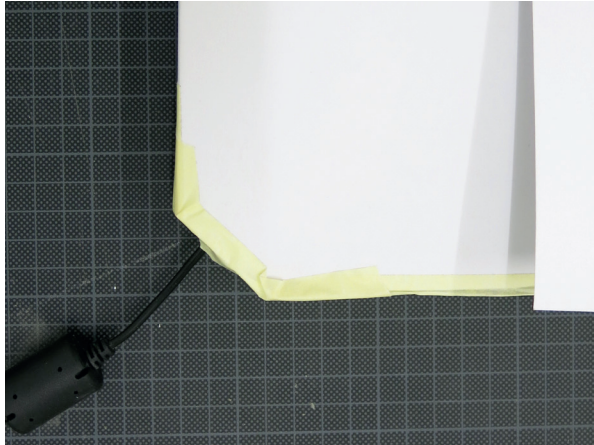
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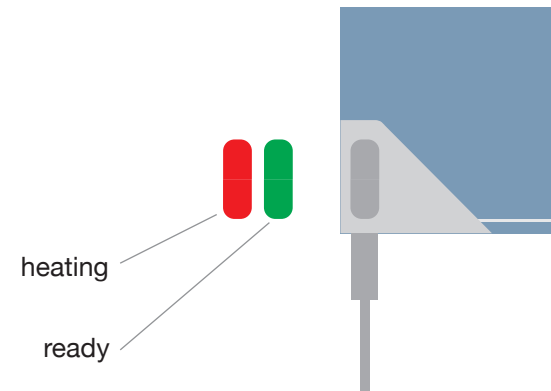
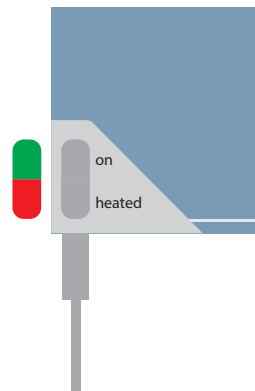
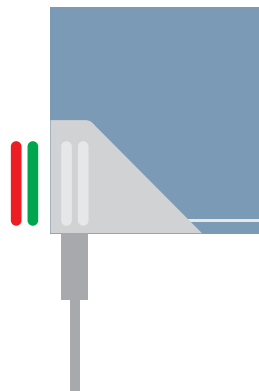
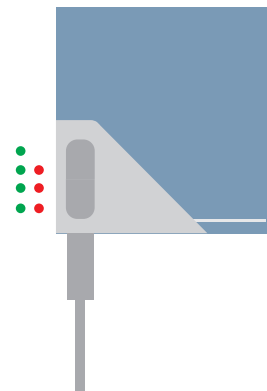
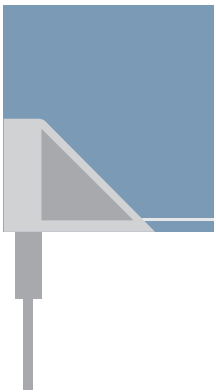
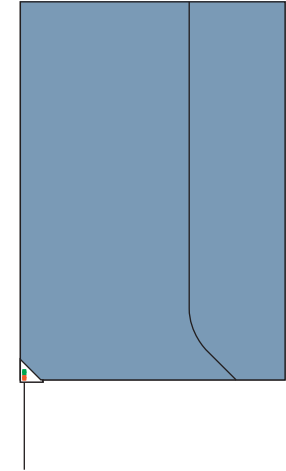
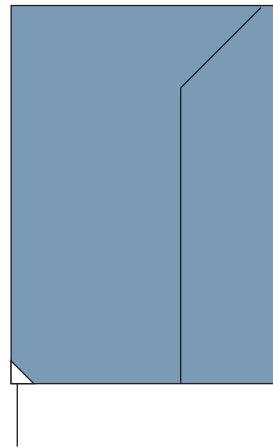
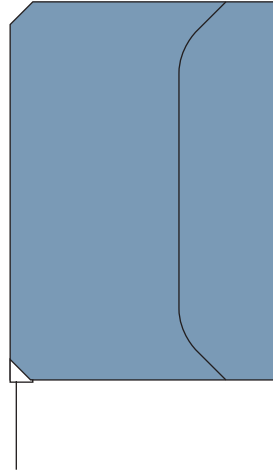
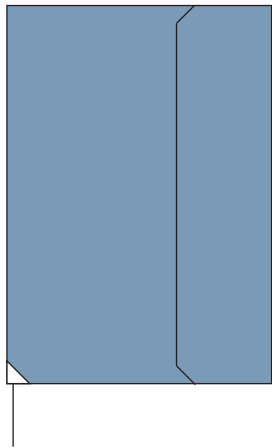
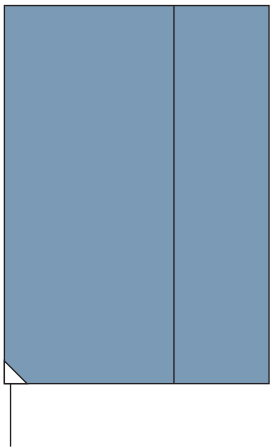


„laptop case“

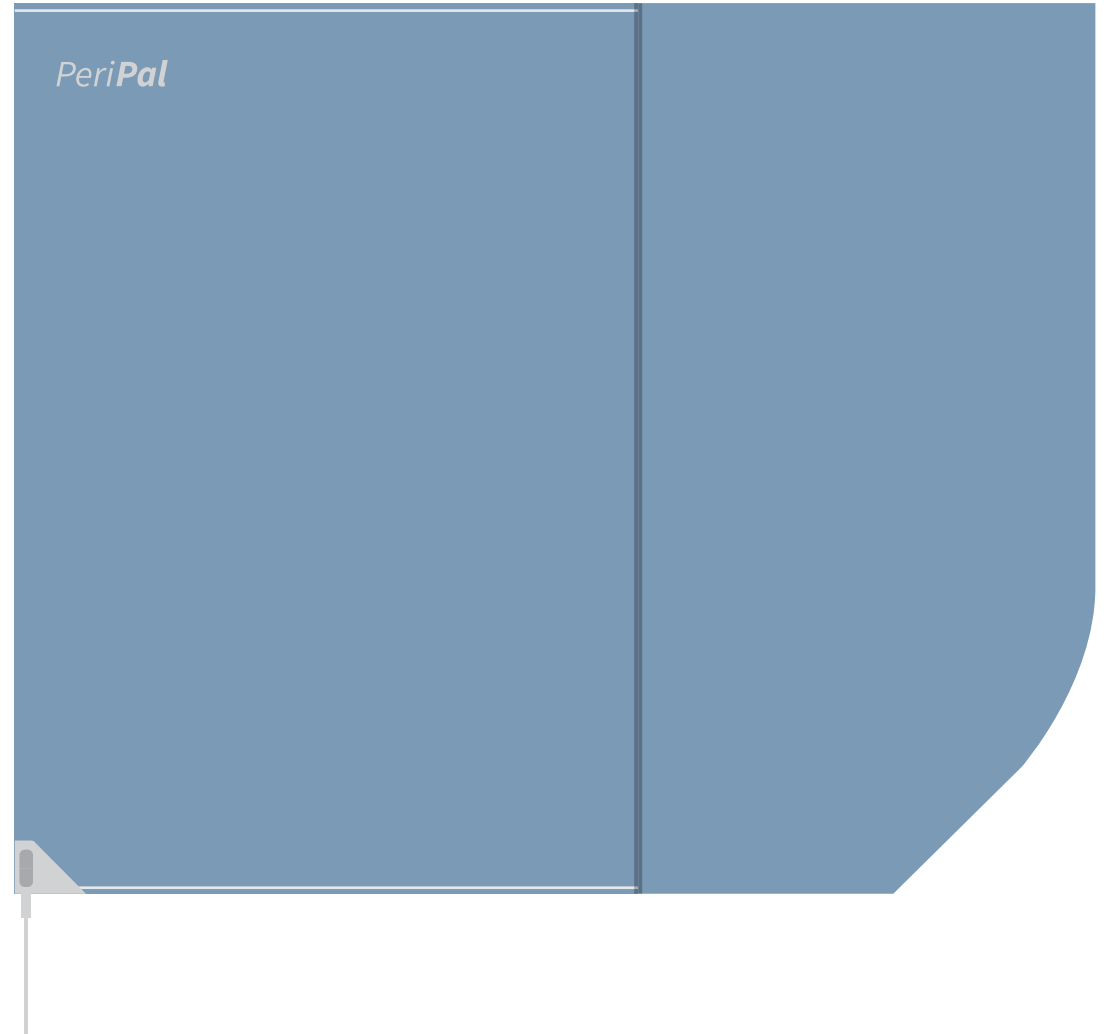
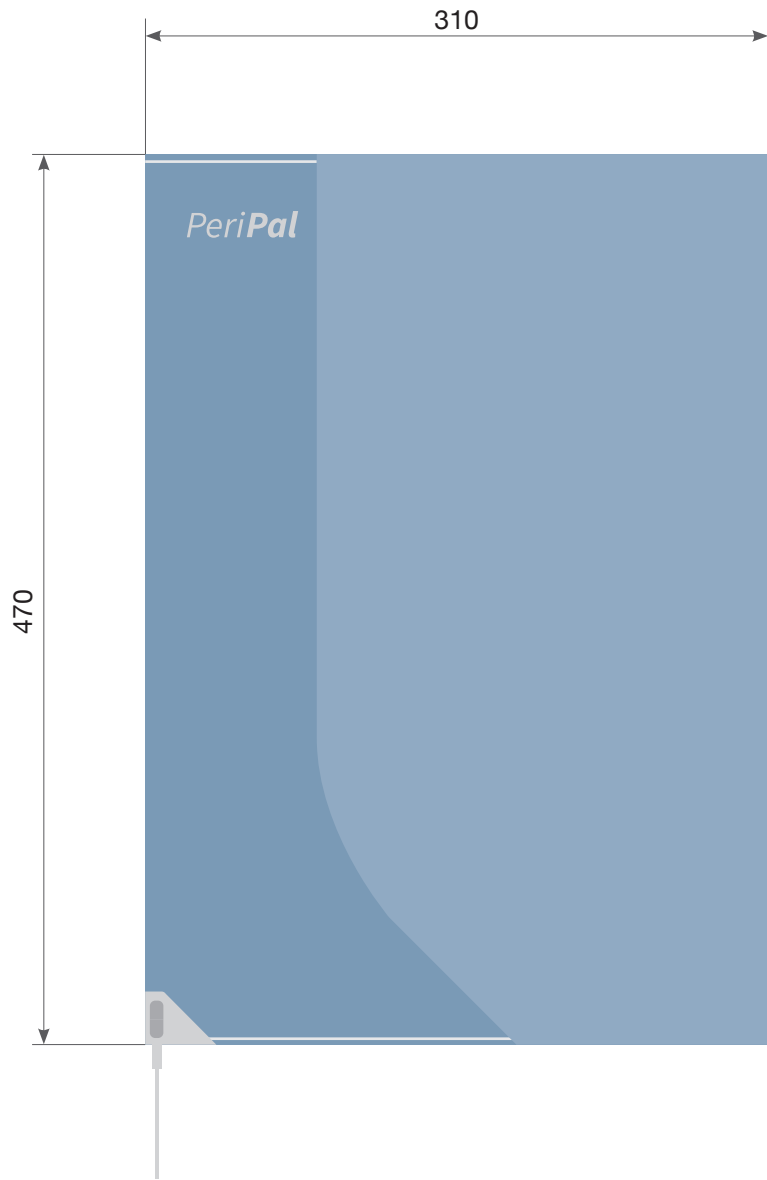


Heating Bag - Thermostat Design





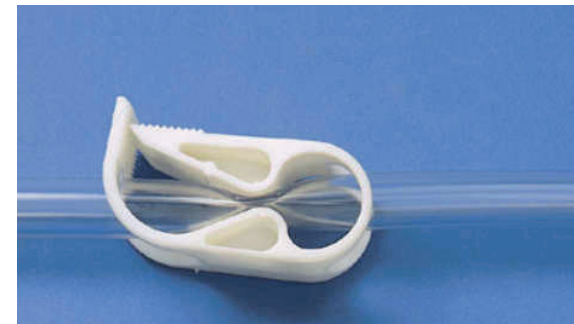
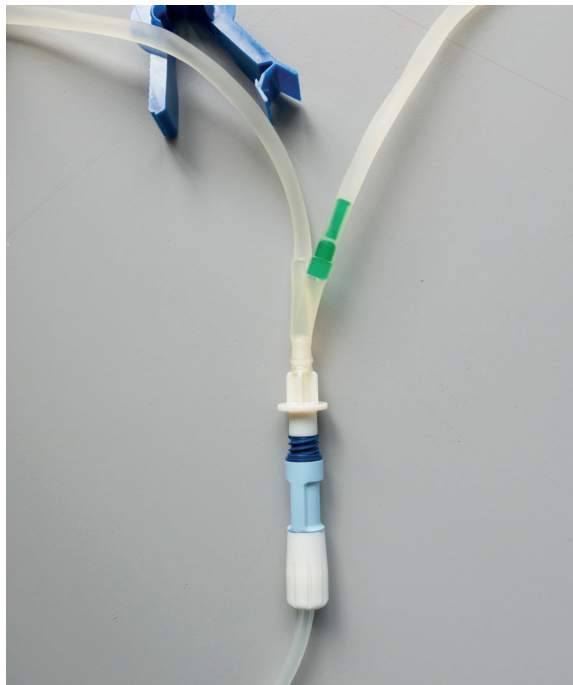
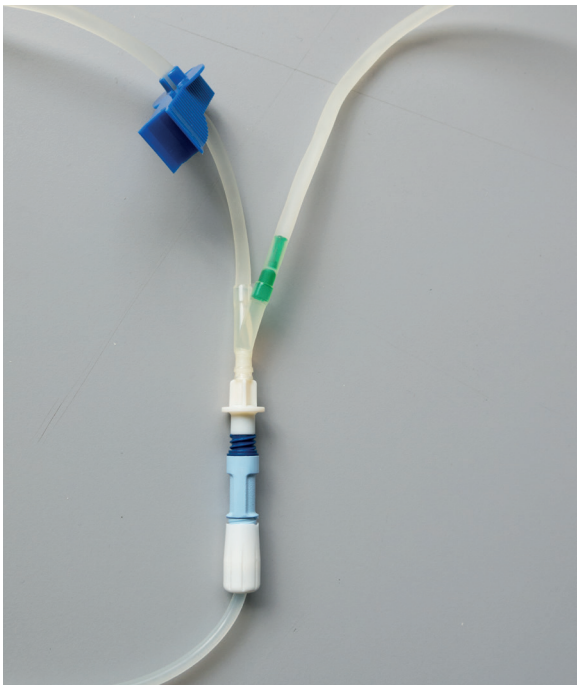
Heating Bag - Final Model



Clamps

During the peritoneal dialysis, the patient has to control where the fluid is going. For this action a clamp is used.
The actual clamp fulfills its function. The patient sees clearly which tube is blocked and which one is free.

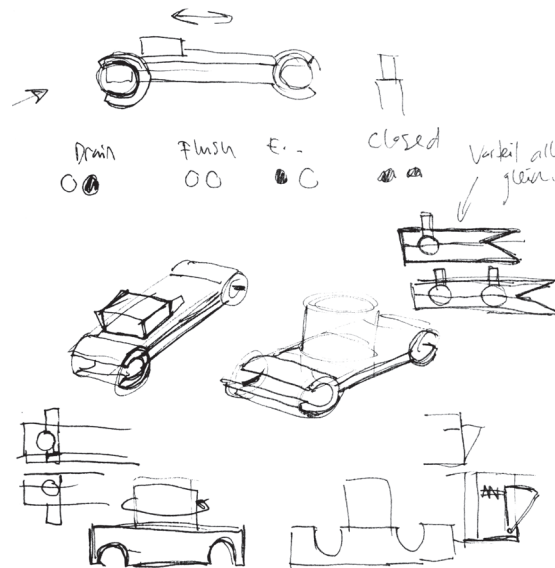
There are clamps that can be fixed to the tube during the fabrication process.
These clamps are small and the user feedback, if the clamp is closed or open, is very weak.



The actual clamp is designed for a one way use. Most of the patients keep using the clamps for a longer time. In the redesign this fact has to be an influence.

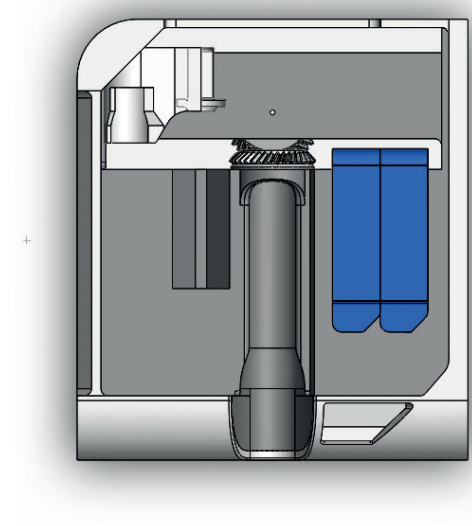


There is a way to integrate the clamps directly into the connector device that the user has not to use clamps. There would be something like a controller on the skid . This would change a lot in the design of the connector and therefore this idea is still kept in mind but does not get realized in this project.

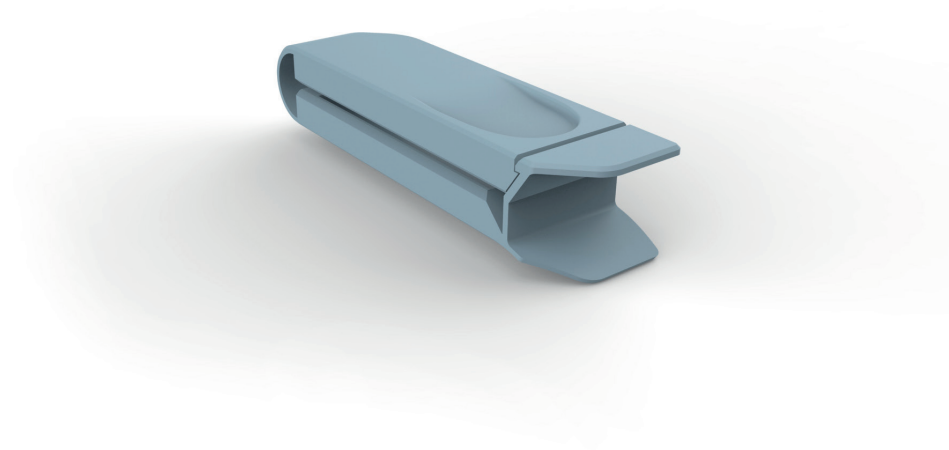
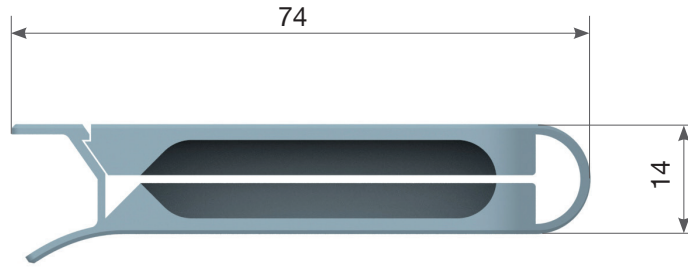


The clamps and the connector are belonging together as a product family because they are used together.

To avoid confusion during the treatment (putting the mini-cap, catheter and twinbag-connector inside) the clamps are not stored in the connector device itself. They are kept separately.



Clamps - Final Design |



| User Scenario |



1



2



3



12



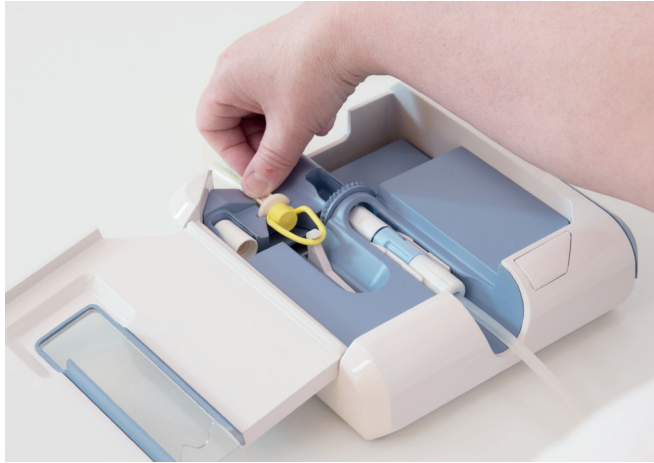
11



10



4



5



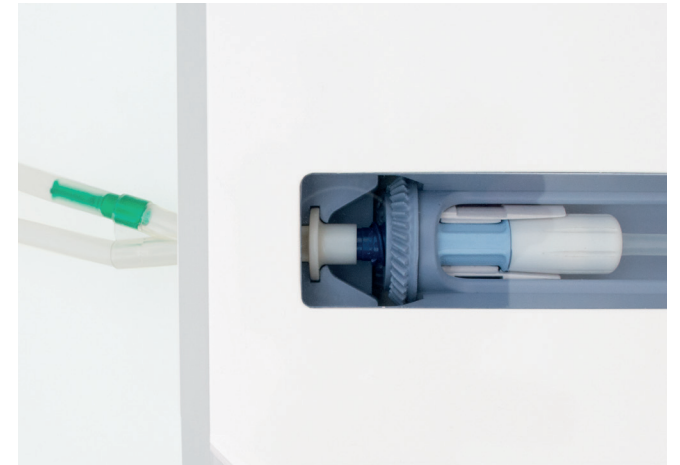
6



9



8



7



PeriPal Heating Bag



PeriPal Connector

