

Design of a wearable sensor to assist hip replacement patients during their physical therapy exercises

Author: Renée Brouwer

In organization with: Awear

30-01-2023

University of Twente

Industrial Design BSc

Summary

This thesis will follow the research executed to find out the most ideal way to incorporate a sensor into a product to assist patients while they perform physical therapy exercises and activities. This will help the start-up company Awear¹ to envision their plans for the future. The sensor they are designing currently has the main focus to assist patients that are in the hospital, but is in the future supposed to assist them at home as well. During the course of this thesis a product has been designed in which this sensor will be incorporated and to help Awear achieve their vision.

The thesis has been written to determine the answer to the question *How and where can the sensors best be integrated during exercises?* As this is a very broad question to answer, the first step was to determine a well underfunded target group that would benefit most from the new product. This turned out to be hip replacement patients. Personas, scenarios and Human Factors research have been made and performed to determine the design requirements to fit the chosen target group, to ensure a fitting product could be designed for them.

For this target group it could then be determined what the most ideal location for the sensor and product would be, answering the sub-question: *How can the sensors be used during different kinds of exercises?* And: *What difference is there between different kinds of exercises?*

To answer these questions an extensive research was done into the exercises hip replacement patients would need to perform. Not only have the exercises been evaluated, pilot tests were performed with Awear's sensor to determine the most ideal sensor location on the leg while performing these exercises, but also a test to determine an almost exact ideal placement. This research has also been used to answer the sub question: *How can the use of the sensors be as streamlined as possible for the patient?* To assist in answering this question more research was also done into the workings of the sensor by answering the questions: *How do the sensors work?* And: *What is needed for the sensors to work?*

After having answered the sub questions with the help of the performed research and pilot tests, three concepts and later a final design were created to fit all requirements set up for this assignment. This resulted in a product that would be comfortable for the patients to use and not limit them in their process of healing.

The result of this thesis is a semi-elastic strap that the patient can wrap around their leg with the help of Velcro, a ring and anti-slip edges. The sensor can then be added to the outside of the leg with Velcro as well, making the product suitable for patients with different kinds of build and physique. The answer of the research question thus being this newly designed product situated on the thigh of a hip replacement patient, with the sensor on the outside of the leg.



Figure 2. The final design.

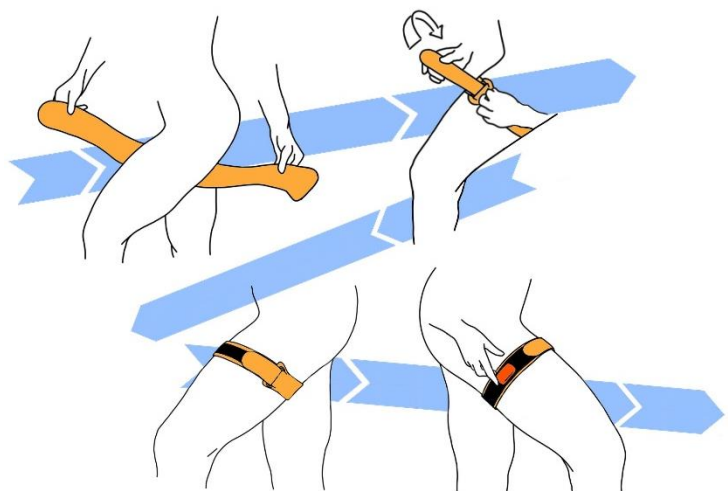


Figure 1. How to put on the product.

1. Awear: Awareness Technology. (n.d.). <https://awear.tech/>

This final design has also been made into a prototype to be tested and evaluated with six participants who wore the product during a series of exercises the target group would also need to perform. The information and graphs produced by the sensor have been assessed and evaluated to determine whether the product and prototype work as intended and to determine future recommendations for Awear were they to continue with the designed product. The participants were also asked questions about the usability and comfortability of the prototype, which all yielded very positive and promising results for the product.

As Awear is still working on an application to go with the newly designed product, some recommendations have been made not just for the product itself, but also the entire envisioned system to be used by the patients and physical therapists in the future.