Designing a wireless pulse-oximeter for children between the age of 0-4 years old.

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Topic or subject: Designing a wireless pulse oximeter

The mission of Revalidation centre Roessingh where this project was executed is “We restore the participation to the society of people with an illness or a disability by means of treatment, research, service and products.” [2] At Roessingh they mostly help people with medical rehabilitation of different illnesses and disabilities. The reason for the assignment is that a young patient at the Roessingh uses a wired pulse-oximeter. However, the cord restricts him in his movements, and could worsen his motoric developmental delay.

A pulse-oximeter is used to measure the amount of oxygen in the bloodstream (SpO2) in a non-invasive way. The normal SpO2 of a human is 95% or more [1], it can be used to ‘predict’ an epileptic attack where the person stops with breathing. Pulse-oximeters are used on patients in hospitals, both adults and babies. However, these will always be wired meters, and this restricts the range of freedom for the patients. Also, when there is too much movement the sensor may move and lose contact with the tissue, which can give false readings.

Research question: How can a (new) pulse oximeter be designed in such a way that it will give more freedom to a child of the age of 0-4 years old, that uses the product for 24-hours a day?

In the analysis phase, the possibilities for a wireless pulse-oximeter were investigated. Mainly how to transfer data wirelessly was analysed, and either Bluetooth or Wi-Fi are the most suitable for the product. Also, the possible ways to measure oxygen saturation in blood was analysed to see what the other possibilities are and to be certain that pulse oximetry would be the best way to do this.
The concern of the client was that with a wired pulse-oximeter the child would get entangled in the cord/wire of the meter and that it may worsen the motoric developmental delay of the child. So, to know where a wireless meter would have the advantage over a wired meter, the motoric development of a typically developed child was analysed. This also gave an insight for the placement of the product, namely somewhere where the sensor would not easily move.
In the ideation phase three concepts were made. The first one (image 1) could be placed around the ear, like a hearing aid. The sensor would be placed on the earlobe with the electronics behind the ear. The second one, a headband with the sensor placed on the forehead above either eye, with the electronics placed next to the sensor. The last one, similar to the headband but then around the chest with the sensor placed on the chest. Because the ear one would be difficult to fit a child from the age of 0 to 4 years old and when looking at if it would stay on, i.e. not able to pull-off by the child, this idea was discarded. From the headband mock-ups were made to see if it would fit and how it would look. During the making of the mock-ups two problems arose. 1. Since, the product is placed on the forehead and to make it look nice, it should be hidden that it is a medical product by making it look like a normal headband, this also contributes to the second problem. 2. Young children may have the tendency to pull it off of their head, with an extra band from front to back over the head, or by making it look like something fun to wear, e.g. something from a superhero or a famous cartoon, children could be more likely to keep it on. However, during a first test the headband slipped off during the night. So, it was chosen to go for the chest band concept.
The chest band concept still needed to be adjusted because a test with an actual child wearing the chestband showed that the band kept slipping down. And all the features needed to be more defined.

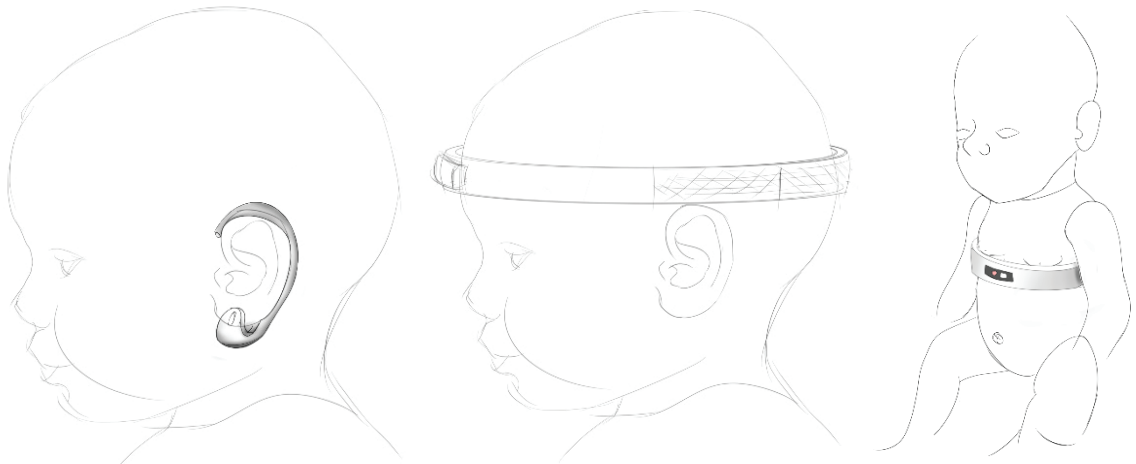

Image 1: Earpiece concept, headband concept, and chest band concept

The end result is a prototype of the chest band (image 2 and 5). There are several differences in the prototype and the final design (image 4). Since, it would be easier to use the electronics of an already existing product, the prototype is bigger, and the sensor and LEDs are placed on top of the printed circuit. While in the final design the sensor and LEDs will be placed next to the printed circuit (image 3). The prototype uses Wi-Fi to send the data to an app on a smartphone, this was chosen because most people own a smartphone and Wi-Fi has the biggest range.

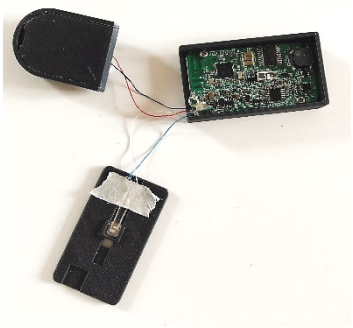

Image 2: Prototype in casing

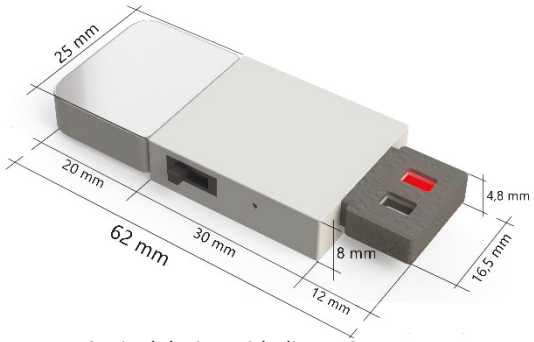

Image 3: Final design with dimensions

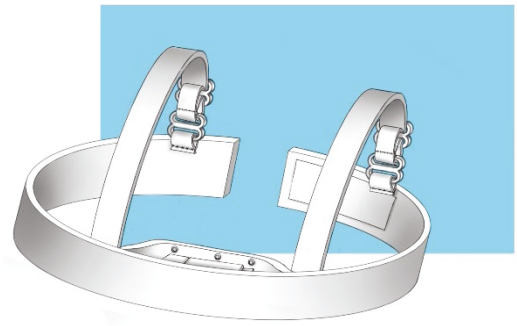

Image 4: Final design

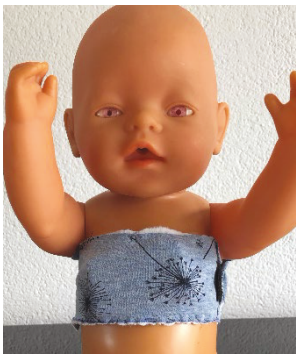

Image 5: Prototype on doll

The product is a wireless pulse-oximeter which can be worn by children between the age of 0-4 years old due to the adjustable fit, and it can be worn 24-hours a day. However, the product needs more research before it can be put on the market. First of all, it should be researched whether the measured data is trustworthy enough, the chestband will then be worn for a longer period of time. Also, the design of the battery casing needs to be researched and made.

Reference

[1] R. Chatburn, "To co-ox or not to co-ox," p. 6, June 2004. [Accessed on: 8 May 2019] Available: https://acutecaretesting.org/en/articles/to-coox-or-not-to-coox

[2] https://www.roessingh.nl/over/missie-en-kernwaarden [Accessed April 3, 2019]