

The development of a device to measure the Hypercapnic Ventilatory Response

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The Hypercapnic Ventilatory Response (HCVR) is the response to a raised carbon dioxide level in the blood that is normally caused by for example physical strain. With a change of ventilation in litres per minute this high percentage of carbon dioxide can be decreased. Currently on the market there is a test that performs the measurement of the respiratory response to hypercapnia. Namely, the wet spirometer. However, this product is banned from the market because of safety issues. Other techniques that are known, but are not used in a product on the market are the HCVR rebreathing or steady state test.

During the master thesis of Denise Mannée the HCVR Rebreathing and HCVR Steady State test are compared on reproducibility. This is done by executing both tests twice on the same test person with a self-made prototype. This prototype is solely functional and not practical or aesthetic. The goal of this assignment is to develop a concept for a product that executes both HCVR tests and is practical in use for both respiratory technician and patient. Next to those requirements it should meet physical and cognitive ergonomic requirements.

The final design is a result of several phases of ideation and detailing. With the use of a morphologic scheme a first ideation is structured with five design directions as result. Those directions are validated using the programme of demands which resulted in one concept. This concept contains several aspects that can be improved separately and combined in the final design.

The final design is mainly a casing for the clinical components of the HCVR test so all components have a determined position which also prevents errors of the system due to incorrect instalment of components. This concept can also be used without supporting products as a table or tripod, only the external components that collect and process all the data are needed.

The product has an respiratory technician and a patient 'side'. The respiratory technician side shows all components including the rebreathing canister which measures the volume during the test to improve the reproducibility. The patient side of the product does not show any technical information about the product or the patient's status. It only contains an arm that ensures the freedom of movement for the patient. This freedom contains tilting the head and sit in a slightly different position during the test without having to worry about components breaking loose.

The result of this study is a concept that is tested on different aspects and proven to be feasible. All components used in the prototype of Denise Mannée are proven to function as they should, as well as the proposed rebreathing canister and the flexible arm providing the freedom of movement.

However, it is a concept that needs further development to be ready for implementation. Firstly, it is important to define all dimensions of the product in combination with the materials and the production methods. Those three aspects are influencing each other through restrictions of certain materials and production techniques, but also the dimensions will exclude certain materials and production types. Through simulations and tests the optimum should be established.

Another aspect that is mentioned in the report that needs further development is the automation of the servo motors. Once these developments have been made the new concept should be tested to

meet the CE marking requirements. When this marking is granted the product can be truly implemented in hospitals.