Pharaoh mattress

The development of a cranio-thoracic immobilizer for patients with cervical injury.

Aniek Colijn, Industrial Design Engineering, University of Twente, The Netherlands

The subject of this bachelor assignment is the designing of a cranio-thoracic immobilizer (Pharaoh mattress) for critical care patients with cervical injury.[1] The assignment was executed and commissioned by Perteon in collaboration with the Radboudumc in Nijmegen. Perteon is a small company, specialized in the design of sit and lie orthoses. These orthoses are all individually formed, so for this universal Pharaoh mattress, further research is needed.

Current immobilization techniques of the cervical spine are associated with complications including pressure ulcers, discomfort and elevated intracranial pressures with limited access to the thorax and airway. [1] The aim of this assignment is to design a production version as a continuation on the existing prototype of a cranio-thoracic immobilizer, also called the Pharaoh mattress. The Pharaoh mattress is a sort of a mattress that restricts neck movements before the operation for patients with mechanically instable spinal fractures. This immobilizer was designed and tested by Radboudumc, but the current version of the Pharaoh mattress is not coated with a special material to prevent soiling. A good material for a cleanable interface between patient and mattress is needed. The main research question of this thesis is therefore; 'Which material is suitable for covering the Pharaoh mattress and which top layer is suitable so that the patient can lie on the mattress for one to two weeks without any problems?'

To obtain a good impression of the production possibilities of Perteon, an analysis of their materials and production methods was done. It came forward that most of the materials used for the Pharaoh mattress are also in use at Perteon. Also, the use of materials and special techniques of Supportec are analysed, because this company can possibly take over the production of the Pharaoh mattress on behalf of Perteon. Out of these analyses several functions and requirements came forward. These are incorporated in a statement of requirements.

During the design phase, all the suitable materials and solutions for certain functions were clarified and expanded. A distinction is being made in this phase between the base of the orthosis, the top layer and its design aspects and solutions for several functions of the Pharaoh mattress. All these possibilities are submitted to two experts, the orthopaedic surgeon and the director of Supportec to use their advice to make the right concept choice. After that, the final concept choice was made based on certain selection criteria, taking into account the possibilities of Perteon and the advices of the experts.

Subsequently, the concept is examined and evaluated during the conceptualization phase. In this phase, the prototype of the Pharaoh mattress that was made by Supportec, was tested by Intensive Care nurses to find out which problems they encountered. By means of these problems, several adaptations were executed which will need some further research in a follow-up research.

To find out what the costs of the Pharaoh mattress would be, the sales market in the Netherlands, Belgium and Germany was investigated. Thereafter, a cost estimation was made based on the costs of the prototype. Since the production cannot be fully executed by Perteon, the production possibilities are examined and it is advisable to do some more research for the possibilities.

The result of the process is a concept for a comfortable, reliable cranio-thoracic immobilizer for patients with cervical injury. The orthosis complies with the guidelines and regulations of the hospital and the remaining requirements. The final design is a coated, cleanable, reusable mattress with several adaptions. Also, a washable slipover was designed to increase the comfort of the patient, even as an adjustable headrest. However, before the final product can be produced, it is advised to do a small follow-up research. This is advisable, because the duration of the use could not be examined, even as the final concept with its adaptations.

References

[1] *Holla, M., Driessen, M., Eggen, T. G. E., Daanen, R. A., Hosman, A. J. F., Verdonschot, N. & Hannink, G. (2017) A new cranio-thoracic mattress for immobilization of the cervical spine in critical care patients. (submitted to the American Journal of Critical Care March 2017) Radboud university medical center, Nijmegen. University of Twente, Enschede.*