



**The Future of Medical Textiles: High-tech For the Well-being of the Patient**

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**ABSTRACT**

*The cooperation of physicians, surgeons, microbiologists, physiologists and textile scientists at the Hohenstein Institutes has produced, over recent years, a multitude of innovative applications for textiles. Since June 2001, the Competence Centre on Medical Textiles, headed by Dr. Dirk Höfer, has addressed issues in this promising field of textile-based solutions for the health service, thus taking even more advantage of the synergetic effects possible at the Hohenstein Institutes.*

*The background to this research work is the increasing life expectancy of the European population as well as the challenges resulting from this development. In order to achieve practical solutions in a limited time frame, the medical sector will have to cope with the problems arising from the introduction of new technologies.*

*Keywords: innovative applications, textile health services*

In 2040 already, the number of people over 60 years will amount to 40 % of the entire population. In 1980, only 22 % of the Europeans belonged to this age group.

Textiles represent an absolutely ideal interface between man and medical treatment facilities, and it would be a loss not to make use of the possibilities they are offering. Innovative medical textiles, for



**In the future, nanocapsules will medically functionalize textile fibers by means of sensors or drug**

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example, could take care of important functions which up to now were covered by consultation at a medical practitioner or by the prescription of medicine.

The spatial separation of doctor and patient opens the field of the so-called „telemedicine“. The crucial importance of medical textiles in telemedicine is based on the fact that sensors and telecommunication systems integrated into the clothing can gather medical parameters of the patient and deliver them to the treating doctor, the hospital, a medical surveying station or an emergency centre. Here the data is being evaluated.

However, the reverse way is also conceivable, i.e. medicine can be administered to the patient according to the

medical advice by special drug-releasing textiles or integrated electronics. Such technologies would allow permanent medical monitoring and optimal medical care especially for older and chronically ill persons, without time-consuming and cost-intensive visits to the doctor or hospital stays. Moreover, they would provide an enormous gain in safety and quality of life for the patients, since the monitoring of body functions can even be used outside the own flat.



**At the Hohenstein Institutes skin equivalents are used to evaluate the functions of medical textiles.**

Telemedicine could thus play a key role in lowering the rocketing costs in the public health service without making any concessions to the quality of the treatment. First precursors to „intelligent textiles“ (I-Wear) have already been presented on several expert meetings, e. g. the so-called „life shirt“ offering fundamental functions for an effective health monitoring. Integrated sensors make it possible to record heart sounds, the respiratory rate as well as the body posture. After being gathered these data can be transmitted to a doctor. So far, however, the „life shirt“ is an extremely unwieldy and expensive prototype.

Within the next few years, new innovative key technologies such as the microsystem technology (MST) and the nano technology are expected to reduce health-parameter-surveying sensors and drug-applying units to the size of a fiber diameter or even smaller. This would provide countless possibilities for a textile-based medical biometry, which is, so far and with existing technologies such as the „life shirt“, impossible or hardly to accomplish. The „intelligent clothing“ of the future will be equipped with integrated micro-sensors helping to survey the most

important general health parameters such as body temperature, blood pressure, respiratory sounds and heart sounds, or will „report“ changes of the patient’s health status.

In principle, a well-directed control of biosignals is also imaginable, for example in the case of illness. Nano sensors applied to textiles could help to establish signs of illness such as enzyme concentrations in case of cardiac diseases, increased blood sugar level of diabetes patients or cholesterol values and nitric oxide concentration in case of strokes or Alzheimer’s disease. Hence, patients could be monitored more intensively during their illness.



**Presently, prototypes such as the „life shirt“ are unwieldy and expensive. The application of nano sensors, however, will revolutionize technology within the next few years.**

Photo: Vivometrics

Fundamentally, drugs also belong to the biosignals that can be monitored by means of textiles. Analytical medical textiles could, for example, survey the blood and tissue concentration of certain drugs, or administer and control them by textile-integrated, miniaturised injectors. First, however, a textile-based form of medication by drug-releasing, nanocapsules-coated textiles has to be achieved. Nanocapsules are tiny hollow capsules consisting of different materials and with a diameter of the 10.000 part of a millimeter, in which drugs or cosmetics can be integrated and applied to

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the wearer during wear. Intensive research is presently carried out in the field of these drug depots which are to be fixed to textile fibres. Compared to conventional systems, sensors integrated into the clothing provide clear: Implanted sensors and drug depots require costly operations and well-tolerated materials, because they hold the risk of an undesirable immune response of the body due to a lack of biocompatibility.

Moreover, external measuring and analysis systems assume a high degree of discipline of the patient, since reliable data can only be obtained under strict obeying of the guidelines, as for example the point in time of the measurement.

Textiles, on the other hand, are worn up to 24 hours a day and work regardless of the wearer's state of health. However, the

additional functions of medical textiles must be provable. That is the reason why the Hohenstein Institutes are intensively working on the development of innovative clothing, as well as on the development of test systems to verify the function of the medical textiles and to further develop them. For this purpose, human in-vitro skin-organ cultures, the so-called skin equivalents, are used because they correspond to a large extent, in function and reaction, to the human skin.

There is no doubt that medical textiles will play an important role in the future. Moreover, additional fields of application regarding personal wellness will emerge, ranging from the surveying of the body functions during sport activities to the application of cosmetic and treatment agents via the textile.



**Dr. Dirk Höfer, Head of Competence Centre on Medical Textiles at the Hohenstein Institutes.**

Photo: Vivometrics

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