Non-invasive sensors for wound monitoring and therapy

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Abstract— **Chronic wounds such as diabetic foot ulcers and venous leg ulcers affect in Europe more than 10 million people, a number that is expected to grow due to the aging of the population. Sensors can be a valid tool to improve the quality of healthcare for wound monitoring and management. The integration of sensor data within health information and decision support systems may allow the delivery of personalized treatments at decreased cost. The EU FP7 SWAN-iCare project is developing a negative-pressure device associated with non-invasive sensors capable to monitor some physiological parameters related to the wound status, such as pH, temperature and transepidermal water loss. These sensors will help to provide personalized therapies to patients and check the effectiveness of treatments remotely.**

I. Introduction

Venous disease, such as chronic venous insufficiency (CVI) and chronic leg ulcers, is one of the most common chronic medical disorders in the Western world. Chronic venous insufficiency is caused by an abnormal venous blood transport in the superficial or deep venous systems [1]. It is reported in medical literature that only 50% of venous ulcers heal at 4 months, whereas 20% remain open even after two years, and 8% are still active after five years [2].

A new generation of wearable negative pressure wound therapy (NPWT) devices is currently being developed in the frame of the SWAN-iCare project to include sensors relevant for the health status of the wound to monitor biological and physiological parameters like pH, skin and wound temperature, and transepidermal water loss (TEWL) [3]. In this paper, we briefly present these three sensors currently under investigation within the SWAN-iCare project.

II. Sensors for Wound Monitoring

pH, temperature and TEWL can play a critical role for the management of chronic and acute wounds. They are associated with infections, fibroblasts activity, keratinocyte proliferation and microbial proliferation, and to the skin integrity [4]. In a pH range of interest from 5 to 9, a promising approach for the fabrication of pH-sensitive nano-composite materials involved the combination of three main components: a film-forming polymer latex (poly(butyl acrylate-co-methyl methacrylate), Sigma Aldrich), a pH-sensitive polymer (poly(acrylic acid), Sigma Aldrich), and electro-conducting nanoparticles (multi-walled carbon nanotubes, Baytubes C150 P). This compound exploits the variations of its electrical properties according to the pH value of the environment [5]. The measurement of temperature focuses on the development of a thermoresistive sensor made by multiwall carbon nanotubes (MWCNT, Baytubes C150 P) and poly(styrene-b-(ethylene-co-butylene)-b-styrene) (SEBS, Europrene Sol TH 212) nano-composite. In a range of interest largely approximated between 20 and 50 °C, the MWCNT/SEBS films showed a variation between 3.8 KΩ and 2.7 KΩ with a deviation of ± 400Ω [6]. Temperature and pH sensors can be integrated in wound dressings for daily monitoring up to one week, whereas the TEWL sensor is wearable and intended for a weekly use. The architecture of the TEWL sensor resembles what it has been reported by Salvo et al. [7], and includes a Bluetooth connection and microSD card for data logging.

III. Conclusions

The development of non-invasive sensors directly integrated in the dressing or connected to a portable NPWT device can be a benefit for both patients and health-care system as these sensors can help to provide remote wound monitoring and therapies.

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