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A Remote Monitoring Platform for the Management of Lower Limb Vascular Diseases

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Abstract. This short paper describes a remote monitoring platform proposed in the Inno4health project. The platform aims to guide patients and clinicians during the treatment of lower limb vascular disorders, namely, to correct abnormal foot pressure and temperature to prevent diabetic foot ulcers and to monitor interface pressure, leg position and elevation for venous ulcers patients.

Keywords. Wearable devices; clinical decision support; vascular diseases; mHealth: remote monitoring; continuous monitoring.

1. Introduction and Methods

Vascular disorders affecting the lower limb, such as diabetic foot ulcers (DFUs) and leg venous ulcers (VUs), can be efficiently addressed by wearable technologies as they require constant follow-up, otherwise leading to considerable loss of quality of life and sometimes the need for hospitalization [1]. The current state-of-the-art includes several systems for continuously monitoring these diseases, but a minority of them enable remote access to patient data. Also, leg VU remains an underexplored field and there are several opportunities to develop innovative wearable devices, namely, to guide routine compression therapy. Automated feedback, recommendations or coaching are also scarce and systems to be used by both, patients and physicians, integrated into the clinical workflow with aid of intelligent services, have not been achieved yet [2]. Thus, one of the aims of the Inno4health project aims is to provide a remote monitoring platform to help professionals and patients detect and actively correct abnormal foot pressure and

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temperature to prevent DFUs, and monitor pressure under compression apparatus, leg position and elevation in the case of VUs.

A remote monitoring platform targeting the diseases was designed according to requirements defined by literature review [2] and clinicians' feedback obtained through in-situ hospital visits and virtual meetings.

2. Results and Conclusions

The platform's architecture comprises a layer that serves as a gateway with external services and implements secure encrypted connections through the Transport Layer Security protocol. A Data Storage component will maintain pseudonymized data collected from wearable devices, and a medical knowledge base. Data processing components will implement a Rule-Based System to produce and display recommendations for coaching based on the medical knowledge base and run intelligent algorithms for insights generation. A patient's mobile application will be used to collect data from wearable sensors, enable platform interaction and display useful information and recommendations. VU patients will wear a patch to measure leg elevation, motion, time spent in different positions, and pressure under compressive apparatus. The patch's design consists of a pillow with an ultra-slim forcing sensor resistor to measure and log the parameters continuously. DFU patients will wear insoles to measure plantar pressure and temperature in 8 points of the foot to detect areas that can evolve into ulcers.
Physicians will interact with the platform through a web portal, where they can visualize (following authentication) the patient's information and actionable insights in real-time. Regarding DFU, physicians will receive alerts to check the patient whenever persistent localized temperature differences above 1.7˚C between the left and right foot occur or when sustained plantar pressure above 35 mmHg is detected. Regarding VU, clinicians will be able to check if patients are complying with the recommendations on proper leg position and elevation and monitor interface pressure. The prototypes of the insoles, mobile application and web portal for monitoring DFU have been concluded. Future work includes the development and integration of the VU patches, the construction of the medical base for generating personalized recommendations, and pilot studies to receive feedback from patients, which can be further used to improve the technologies.

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