THE UPREVENT PROJECT: A SMART IN-SOLE SYSTEM FOR FOOT ULCER PREVENTION IN DIABETIC PATIENTS

V. Fiska*, L. Mpaltadoros*, T. G. Stavropoulos*, G. E. Dafoulas**, A. Bargiota**, S. Poulios***, T. Patas***, G. Giakas****, G. Bellis****, S. Nikolopoulos*, D. E. Tsaopoulos*, I. Kompatsiaris*

* Centre for Research & Technology Hellas (CERTH-ITI, -IBO), Thessaloniki & Larisa, Greece
**Faculty of Medicine, University of Thessaly, Larisa, Greece
*** Polytech, Larisa, Greece, **** Biomechanical Solutions (BME), Karditsa, Greece
{vickyfi, lamprosmpalt, athstavr, nikolopo, ikom}@iti.gr

Introduction

It is estimated that on an average every 30 seconds an extremity is amputated due to complications of diabetes mellitus and the majority of these amputations are secondary to foot ulcers. Diabetic foot ulcer is not only a patient problem but also a major health care concern throughout the world [1]. This paper presents the uPrevent project's [2] approach for a smart in-sole system to prevent foot ulcers in diabetes patients.

State of the Art Review

A literature survey on footwear sensors and actuators for diabetic ulcer foot prevention is presented on Table 1. A few technologists start to emerge (majority in 2017-2020), yet do not yet allow for frequent and efficient adaptations of the in-sole.

Table 1: Existing studies in literature in each category

Index	Category	# Studies
A.	Insole Sensing Technologies	6
B.	Interactive Insole Pressure Change Technologies	8
C.	Software: Data Models & Interactive Patient/Doctor Apps for eHealth/Foot	11
D.	Medical: Guidelines, Practices, Clinical Trials	17

In-Shoe Sensor and Actuator Solution

An initial UPrevent prototype was implemented as a metal surface insole and glued nuts, re-distributing tread morphology by adjusting the height of screws. An evolved prototype consists of a thick silicone tread surface with an integrated mesh for the adjustment of the axes, the selection of tread surface areas, the connection to a specific number of axles, and the selection of stepper motors adjusting with the shafts for automated adjustment of the areas, according to the results of the piezometric analysis, in order to optimize the surface pressure.

Integrated Intelligence and End-user Apps

While the embedded insole system enables sensing and change, its integration as part of a larger, AI-enabled system will allow smart decision making (Figure 1). Personalized insole geometry will consider general best practices and thresholds exceeded but also computational models of patients through trials. Apps will enable patients to self-manage their condition and doctors to remotely monitor and take timely decisions by viewing metrics.

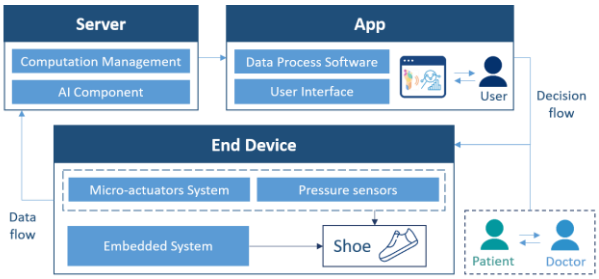

Figure 1. uPrevent System Architecture

Discussion & Conclusion

UPrevent proposes a smart insole prototype for foot ulcer prevention in diabetic patients that combines pressure sensors and actuators with intelligent decision making. Embedded technology allows frequent and effective redistribution of high-risk pressure in localized plantar regions. Pilots at the Larisa General Hospital in Greece as a feasibility study to assess safety and efficacy of the near-to-final device for patients.

References

1. Iraj B, Khorvash F, Ebneshahidi A, Askari G. Prevention of diabetic foot ulcer. *Int J Prev Med*. 2013;4(3):373-376.
2. The uPrevent Project: https://uprevent-project.gr

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Smart Insole, foot ulcers, Diabetes, Sensors, Actuators

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