A novel, adaptive decision support system for diabetes self-management using artificial intelligence and mathematical modelling

pepper
patient empowerment through predictive personalised decision support

Introduction

PEPPER (Patient Empowerment through Predictive PERsonalised decision support) is a research and innovation project to develop a personalised clinical decision support system for Type 1 diabetes self-management. The tool provides insulin bolus dose advice and carbohydrate recommendations, tailored to the needs of individuals. The former is determined by Case-Based Reasoning (CBR, Fig. 1), an artificial intelligence technique that adapts to new situations according to past experience. The latter uses a model-based approach (Fig. 2) that also promotes safety by providing glucose alarms, low-glucose insulin suspension and fault detection.

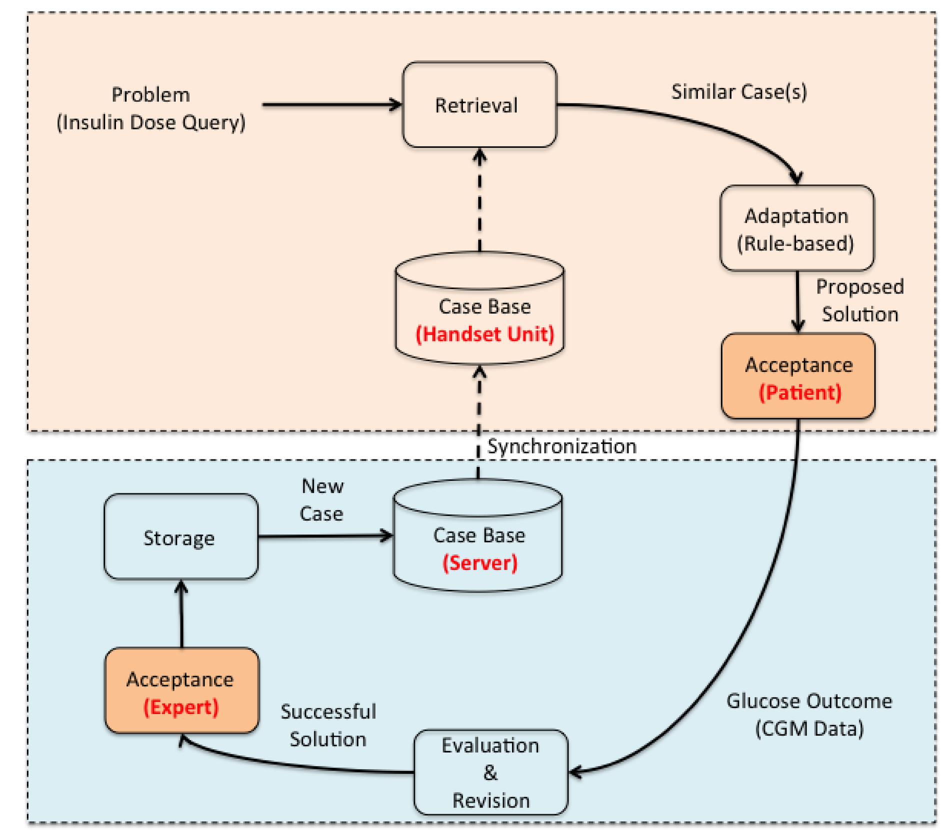

Fig. 1 CBR cycle, adapted to the problem of calculating an insulin dose

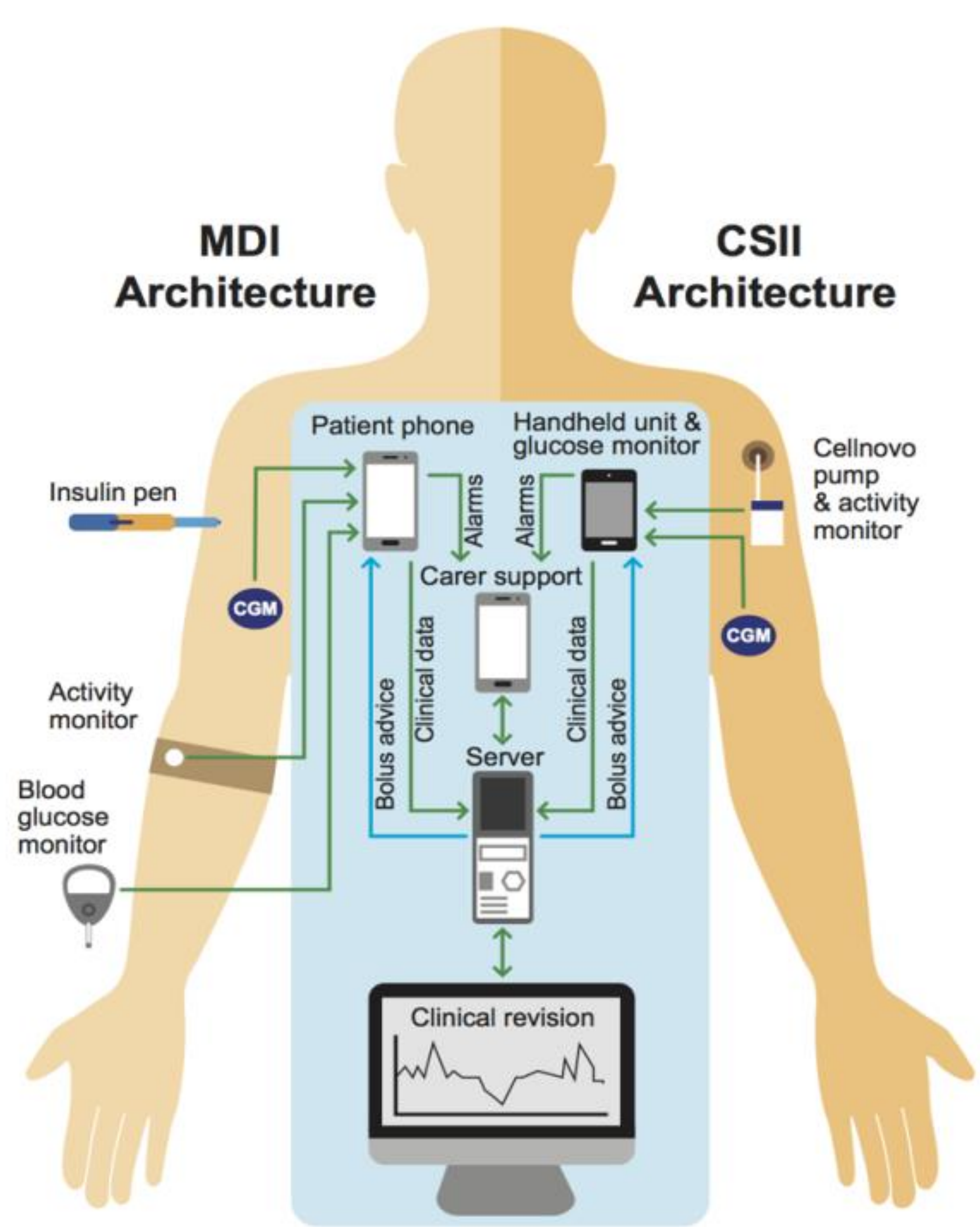

Fig.3 The PEPPER system architecture

Results

The first prototype system has been designed, using feedback from patients and clinicians, and tested in multiple stages. Initial models were tested using the UVA/Padova Type 1 diabetes simulator. Two subsequent phases of clinical tests on patients in the UK and Spain are also complete. The first tested the safety system, the second was concerned with the CBR. Both phases included usability studies.

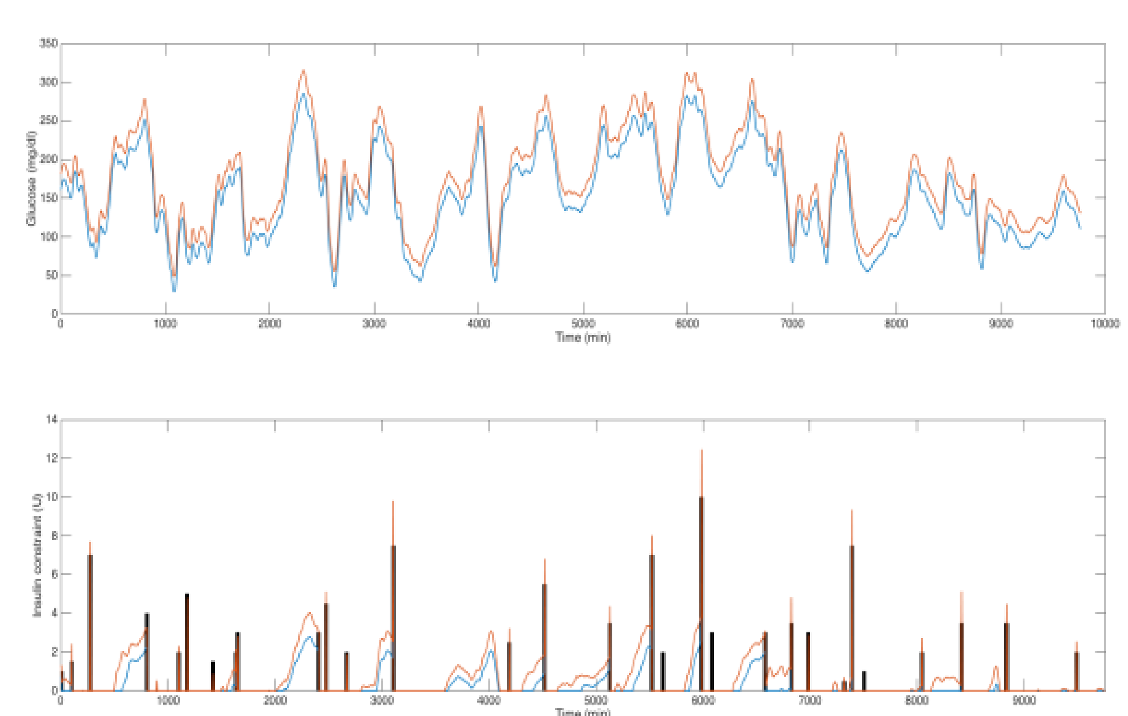

Fig.2 Example of the dynamic constraints using retrospective clinical data. Upper graph: glucose levels represented by an interval envelope. Lower graph: Vertical black bars represent the actual boluses; the envelope represents the constraint.

Method

The user-centred design methodology aims to ensure that the tool meets patient needs and improves clinical outcomes. A dual architecture (Fig.3) accommodates insulin dosing either by insulin pen or via the Cellnovo patch-pump (Fig. 4). Data are gathered wirelessly in real-time from multiple sources including a continuous glucose monitor, capillary glucose monitor and physical activity monitor. The design ethos is to offer maximum benefit for minimum effort, so additional manual data entry is strictly limited.

Conclusions

The first milestones have been reached towards the integration of multiple types of real-time data into a mobile decision support system that uses artificial intelligence and predictive modelling to adapt its advice according to the needs of the individual. The feasibility studies have shown that the system is read for use in the randomised control trial in 2019.

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