A Predictive Algorithm for the Administration of Corrective Insulin Bolus for Decision Support Systems in Type 1 Diabetes

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Abstract— **Type 1 diabetes management can be improved by leveraging decision support systems (DSSs), specific tools that, by suggesting therapeutic actions, can assist patients during decision-making process, reducing their daily burden routine. This work proposes a predictive algorithm for DSSs aimed at generating preventive corrective insulin boluses (CIBs) to reduce the duration of hyperglycemic events. Our approach is compared with a recent heuristic-based methodology proposed by Aleppo et al. and it is retrospectively assessed on a dataset recorded in free-living conditions. Preliminary results indicate that the proposed predictive CIB strategy decreases the time above range, largely increases the percentage of time spent in euglycemia without increasing the time spent in hypoglycemia.**

I. INTRODUCTION

Type 1 diabetes (T1D) is a chronic autoimmune disease characterized by the lack of insulin production and, consequently, the inability to keep the blood glucose (BG) level in a safe range ([70-180] mg/dL).

Standard T1D therapy consists in periodical injections of exogenous insulin boluses to compensate BG fluctuations due to meals intake. The use of continuous glucose monitoring (CGM) devices (which provide a BG value every 1-5 minutes), portable pumps for continuous subcutaneous insulin infusion (CSII) and mobile application, enables the development of decision support systems (DSSs) that can support patients in their decision-making process and considerably improve the management of T1D.

The aim of this work is to propose a new predictive algorithm that can be used in DSSs for suggesting preventive corrective insulin boluses (CIBs) to reduce the duration of hyperglycemic events and to compare its performance vs a recent heuristic-based strategy proposed by Aleppo et al. [1].

II. METHODS

The new algorithm for the generation of a preventive CIB in *real-time* works as follows: i) a first-order polynomial is fitted on the CGM samples available in the last 15 minutes; ii) the fitted model is used to forecast the future BG value 20-minute ahead in time; iii) if the predicted BG is above the severe hyperglycemic threshold (i.e., 250 mg/dL) a preventive CIB is administered according to the Standard Formula:

$$CIB = (BG - BG\_target)/CF - IOB \quad (1)$$

where *BG_target* (mg/dL) is the patient target BG level, *CF* is the patient correction factor and *IOB* is the insulin on board. Of note, the algorithm implements a shut-off system that prevents delivering additional CIB within 1 hour from the last CIB and within 2 hours from the last meal. As a comparator, we implemented the algorithm proposed by Aleppo et al. [1] which suggests CIB according to the BG rate of change.

The assessment of the methodology was performed using ReplayBG [2], a novel tool that retrospectively assesses the outcome of alternative therapy regimes on real-world T1D data. From the OhioT1DM dataset [3], we extracted several monitoring days (n=15) on which applying both algorithms.

III. RESULTS

Table I details the distribution of Time In Range (TIR), Time Above Range (TAR) and Time Below Range (TBR) in terms of median and [IQR] ranges for the baseline and the proposed approach. Median values of TIR and TAR have been significantly increased and decreased (respectively), without leading to any increase to TBR due to the additional insulin delivered.

TABLE I. RESULTS

Algorithm	*Temporal metrics*		
	TIR (%)	**TAR (%)**	**TBR (%)**
Aleppo's	41.86 [27.55 52.96]	50.23 [38.67 56.62]	0.00 [0.00 18.17]
New Predictive Algorithm	**49.77 [41.47 58.01]**	**48.23 [38.61 58.29]**	**0.00 [0.00 0.35]**

IV. CONCLUSION

We proposed a new predictive algorithm for the generation of preventive CIBs, which proved to be effective in decreasing hyperglycemia duration without increasing the time in hypoglycemia. Future works will further validate the proposed methodology on a larger dataset.

REFERENCES

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