COORDINATING LOW-GLUCOSE INSULIN SUSPENSION AND CARBOHYDRATE RECOMMENDATIONS FOR HYPOGLYCAEMIA MINIMISATION

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Objective

- Predictive low-glucose insulin suspension (PLGS) systems have been proven to be an effective way to reduce hypoglycaemia [1].
- Carbohydrate recommenders (CR) have also shown to be a successful method to protect against hypoglycaemia [2].
- The simultaneous utilisations of these two methods might lead to hyperglycaemia due to the overlapping effect of the two interventions.
- In this work, we present an effective strategy to coordinate the use of PLGS and CR to reduce the risk of hypoglycaemia without increasing hyperglycaemia.

Methods

Glucose Forecasting

- A validated model-based glucose forecasting algorithm **[3]** is used by both the PLGS and the CR methods.

Predictive low-glucose insulin suspension

- Basal insulin delivery is reduced by 50% (partial suspension) if the forecasted glucose value falls below a set threshold and fully suspended when forecasted glucose falls below a second set threshold.

Carbohydrate recommender

- When hypoglycaemia occurs, the recommended carbohydrate dose is calculated as,

$$CHO_{rescue} = \left| \frac{G_{sp} - G_f}{CSF} - COB \right|,$$

where G_{sp} is a predefined setpoint, G_f is the forecasted glucose concentration, CSF is the carbohydrate sensitivity factor, and COB is a carbohydrate on board estimation.

Coordination

- The CR accounts for the insulin suspension time by modifying G_f as follows

$$G_f' = G_f + Basal \cdot ICF \cdot T_s \cdot K,$$

where *ICF* is the insulin correction factor, *Basal* is the basal insulin rate, T_s is the suspension time and K is a tuning factor.

In Silico Testing

- The UVa-Padova T1DM simulator [4] using the virtual adult population (n=10) over one-month (30 days) scenario was used for evaluation purposes.
- For all interventions, forecasting horizon, suspension thresholds, maximum suspension time were optimized at a population level.
- The proposed coordinated strategy was compared against the PLGS, CDR algorithms, and the simultaneous utilisation of these two methods without coordination.

Results

Intervention	Mean BG mg/dL	% time <70 mg/dL	% time >180mg/dL
PLGS	137.6±8.8	1.77±0.70	15.48±6.44
CR	134.0±11.8	2.70±1.39	13.14±7.88
PLGS+CR Uncoordinated	147.0±18.6	0.86±0.52	20.05±12.47
PLGS+CR Coordinated	**140.2±10.8**	**0.96±0.65**	**16.48±7.67**

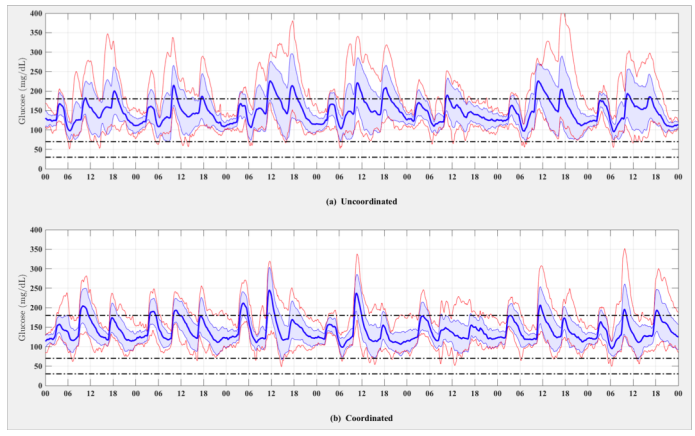

Fig 1. Uncoordinated vs. coordinated PLGS+CR strategies. Average glucose levels for the virtual adult population (n=10) over a one-week period (solid blue line. STD is showed in blue shade, and the maximum and minimum glucose trend in solid red line.

Conclusion

- When compared against individual intervention with PLGS and CR, as well as, simultaneous uncoordinated interventions (PLGS+CR), the proposed method for coordinating the PLGS and CDR algorithms provides an overall improvement in glycaemic control.

References

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