A METHOD FOR ESTIMATION OF GLUCOSE APPEARANCE RATE AND PREDICTION OF BLOOD GLUCOSE LEVEL WITHOUT MEAL ANNOUNCEMENTS IN ANIMAL STUDIES

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Background and Aims
In fully automated artificial pancreas (AP) systems, the estimation of the intestinal glucose absorption rate (GAR) and prediction of blood glucose level (BGL) present challenges while they would provide vital information for model-based control. In this study, we developed a technique to estimate GAR and predict BGL in dual-hormone APs with IP infusion. Its performance was tested in three anesthetized pigs.

Method
The estimator was developed based on the moving horizon estimation (MHE) method, wherein the cost function, we integrated statistical data concerning the GAR in subjects throughout the day [1]. As shown in Fig. 1, the prediction scheme was formulated to anticipate GAR by leveraging estimated states and the intestinal model [2], subsequently employing the animal model [3] to predict BGL. In the proposed method, we aimed to directly estimate the GAR across the MHE horizon, utilizing information about patients' lifestyles. We hypothesized that GAR (G) is an input characterized by a probability distribution function (PDF) fG(G) and the alternating PDF of fAP(ΔG). To find the PDFs, we can employ a model incorporating both intestinal factors and exercise, generating GAR in accordance with patients' lifestyles. An example of fG, fAP(G), and fAP(ΔG) is shown in Fig 2. The found PDFs are then integrated in the cost function of the proposed estimator.

Results
The proposed structure underwent assessment in three anesthetized pigs, with a mean absolute percentage error (MAPE) of 21.8% for GAR estimation. For a prediction horizon of 120 minutes, the suggested predictor demonstrated an 18.0% MAPE for GAR and a 28.4% MAPE for BGL. As shown in Fig. 3, in anesthetized pigs, insulin and glucagon were given intraperitoneally and glucose was given via the intravenous route. Fig. 4 depicts the performance of the proposed method in one of these animal experiments. The reliability of the estimates is studied more in detail in [1].

Conclusion
The results suggest a promising performance of the proposed method. The results suggest a promising performance of the proposed method, showcasing its promise for integration within a fully automated artificial. The proposed method could also be used in single hormone subcutaneous APs by replacing the model [3] with a subcutaneous AP model.

References

Fig. 1. Structure of the proposed method.
Fig. 2. Example of the generated GAR (G), found fG(G), and found fAP(ΔG).
Fig. 3. Experimental setup.
Fig. 4. Performance of the proposed estimator and the predictor for the first animal experiment. BGL, Blood Glucose Level; CGM, Continuous Glucose Measurement; GAR, Glucose Appearance Rate; AP, Intravenous.