Fully Closed Loop Multiple Model Probabilistic Predictive Controller (MMPPC) Artificial Pancreas (AP) Performance in Adolescents and Adults in a Supervised Hotel Setting

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Introduction

- First Generation Artificial Pancreas systems do not eliminate the burden of pre-meal insulin dosing and will provide suboptimal benefits if patients forget to bolus.
- MMPPC is a fully closed-loop system which uses probabilistic estimation of meals to allow for automated meal detection.
- Here we describe the performance of the MMPPC system with adaptive hypoglycemia minimization in a supervised hotel setting.

Methods

- The MMPPC system was tested for 72 hours in 6 adults and 4 adolescents (30% female, 23 years-old, 10.6 years of T1D, 8.1% enrollment A1c) across 3 clinical sites with daily exercise and meal challenges involving both announced and unannounced meals.
- Controller aggressiveness was adapted daily based on prior hypoglycemic events.

Table 1. Glycemic Outcomes from MMPPC Outpatient Use

	Full Day	Overnight (11PM-7AM)
Mean CGM Glucose	157.4 ± 14.4	140.4 ± 25.6
% Time CGM <50 mg/dL	0.3 ± 0.3	0.5 ± 0.8
% Time CGM <70 mg/dL	2.9 ± 2.3	4.1 ± 4.6
% Time CGM 70-180 mg/dL	63.3 ± 9.3	75.0 ± 14.6
% Time CGM >180 mg/dL	33.5 ± 10.0	20.6 ± 15.3
% Time CGM >250 mg/dL	9.0 ± 3.9	3.9 ± 6.3

Results

- Mean 24-hour CGM glucose was 157 mg/dL, with 63.3% of readings between 70-180 mg/dL, 2.9% of readings <70 mg/dL, and 9.0% >250 mg/dL.
- Moderate hyperglycemia was relatively common with 24.5% of readings between 180-250 mg/dL, primarily within 3 hours of a meal.
- Overnight mean CGM glucose was 140 mg/dL, with 75.0% between 70-180 mg/dL, 4.0% <70 mg/dL, 16.8% between 180-250 mg/dL, and 3.9% >250 mg/dL.
- Breakfast glycemic peak was higher for unannounced meals with values normalizing by 2-3 hours post-meal.

Conclusions

- Adaptive MMPPC was effective in a supervised setting despite meal and exercise challenges.
- Further studies are needed in a less supervised environment with additional mitigations to prevent exercise induced hypoglycemia.

Figure 1. Comparison of Postprandial CGM Response for Announced and Unannounced Breakfasts. Breakfast was standardized as ~60g of carbohydrate with similar meals consumed on Announced and Unannounced days.
Solid lines indicate mean CGM, Shaded regions indicate 25th to 75th percentiles.