SUPPLEMENTARY DATA

The Control Algorithm

The PID algorithm with IFB is represented by the following equations:

$$P(n) = Kp[SG(n) - target]$$

$$I(n) = I(n-1) + \frac{Kp}{T_I}[SG(n) - target]$$

$$D(n) = Kp \times T_D \times dSGdt(n)$$

$$PID(n) = P(n) + I(n) + D(n)$$

$$I_{SC}(n) = \alpha_{11} \times I_{SC}(n-1) + \beta_1 \times I_D(n-1)$$

$$I_P(n) = \alpha_{21} \times I_{SC}(n-1) + \alpha_{22} \times I_P(n-1) + \beta_2 \times I_D(n-1)$$

$$I_{EFF}(n) = \alpha_{31} \times I_{SC}(n-1) + \alpha_{32} \times I_P(n-1) + \alpha_{33} \times I_{EFF}(n-1) + \beta_3 \times I_D(n-1)$$

$$IFB(n) = \gamma_1 \times I_{SC}(n) + \gamma_2 \times I_P(n) + \gamma_3 \times I_{EFF}(n)$$

$$ID(n) = (1 + \gamma_1 + \gamma_2 + \gamma_3) \times PID(n) - IFB(n)$$

In this equation, "n" is the most recent time value, and "n-1" represents the time 1 minute prior to this. SG(n) corresponds to sensor glucose (the mean of the glucose values from each sensor SG_1 and SG_2) and dSGdt(n) denotes the rate of change of SG. Real-time estimates of subcutaneous insulin concentration [I_{SC}(n)], plasma insulin concentration [I_P(n)], and interstitial insulin concentration [I_{EFF}(n)] were obtained from the closed-loop insulin delivery [I_D(n)] profile. Insulin feedback [IFB(n)] was calculated by taking a weighted summation of the three insulin states, where γ_1, γ_2, and γ_3 were set at 0.64935, 0.34128, and 0.0093667, respectively.

Algorithm parameters were set as follows; K_P (gain) was individualized, and dependent on the participants' total daily dose (TDD) (K_P = TDD/2250). T_D and T_I were 150 and 40 minutes respectively. The glucose target was 120 mg/dL (6.6 mmol/L). Insulin PK model parameters α_{11}, α_{21}, α_{22}, α_{31}, α_{32}, α_{33}, β_1, β_2, and β_3 were set to 0.9802, 0.014043, 0.98582, 0.000127, 0.017889, 0.98198, 1.1881, 0.0084741, and 0.00005, respectively.