Virtual Patients Derived from the CareLink Database

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Background: The CareLink™ database has been used to generate a large number of virtual patients that can be used for in silico testing.

Methods: Each virtual subject was trained from 20 days of CareLink™ data. Using data from the ASPIRE Clinical Trial[1] and from the MiniMed™ 670G hybrid closed-loop (HCL) study[2], the virtual patients were validated. Insulin action speed and meal absorption rates used in the mathematical model were validated with published literature. Thereafter, a mathematical model was developed with a tailored parametric optimization method.

Results: A total of 2087 virtual patients were generated. Circadian rhythm in daily insulin sensitivity was identified in 1696 virtual patients. In addition, each virtual patient was associated with specific meal absorption rates, an age group, and a total daily dosage of insulin. Table 1 summarizes the comparison between the original 2087 CareLink™ patients' sensor glucose measurements and the 2087 virtual patients glucose predictions. Figure 1 presents the overall concordance of 24-hour sensor glucose (SG) from the CareLink™ patients and Simulation Study virtual patients.

Conclusion: The Medtronic CareLink™ database was demonstrated to be a rich database for producing a large number of virtual patients with a variety of time dependent insulin sensitivities, variable pharmacokinetics, and meal absorption rates. These virtual patients can be used to advance further refinements in the development of artificial pancreas algorithms and automated insulin delivery systems.

Table 1. Glucose Levels for CareLink and Virtual Patients

	Mean glucose mg/dL	Glucose 70-180 mg/dL	Glucose <70mg/dL
CareLink Patients	153	71	2.1
Virtual Patients	157	71	2.1

Figure 1. Aggregate validated SG predictions, midnight to midnight, from the Simulation Study (solid line [median] pink range [IQR 25, 75] and CareLink SG measurements (dotted line [median], gray range [IQR25, 75]).
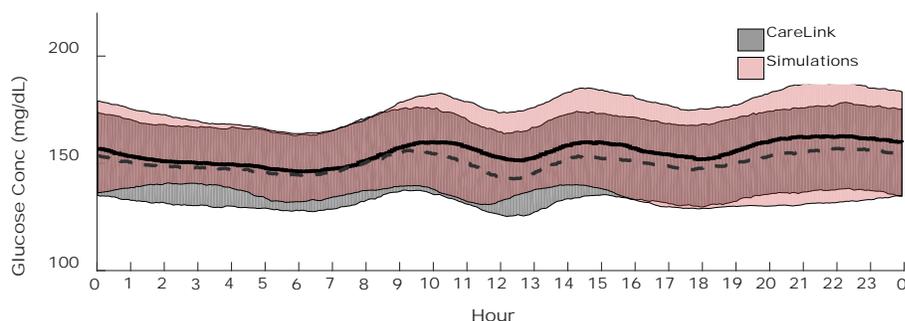
References
1. Garg, Brazg, Bailey et al., Reduction in duration of hypoglycemia by automatic suspension of insulin deliver: the in-clinic ASPIRE study. Diabetes Technol Ther, 2012.
2. Bergenstal, Garg, Weinzimer et al., Safety of a hybrid closed-loop insulin delivery system in patients with type 1 diabetes, JAMA, 2016.