Measures derived from patient generated health data provide insights on glycemic control beyond A1C for people with type 2 diabetes

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Background: Measures beyond A1C are needed to identify clinical glycemic control issues such as wide BG variations and very high and very low BGs. Such metrics may correlate with quality of life (QOL) and risk of significant adverse health outcomes. For people with type 1 diabetes using continuous glucose monitors, parameters that reflect glycemic variability and percent time in range have been proposed.
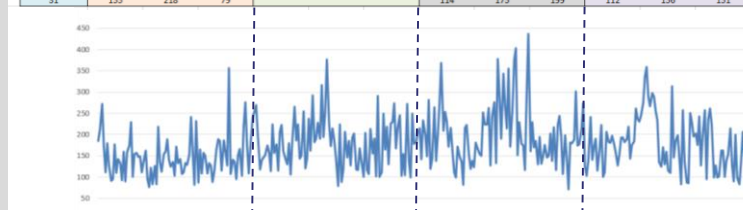
Type 1 diabetes	Type 2 diabetes
Dense BG data	Sparse BG data
CGM, frequent SMBG	Infrequent SMBG
Insulin therapy only	Insulin and non-insulin therapies

Methods: We constructed the following measures that are more suitable for people with type 2 diabetes who generally have sparse data. We evaluated how useful these metrics would be for real de-identified patient data coming from a user of a digital health tool (BlueStar, WellDoc, Inc., Columbia, MD).

SDF………………………………………………………………....standard deviation fasting
SDNF……………………………………………………….....standard deviation non-fasting
NLD………………………….# days per month that a hypo (BG <70) is recorded
NHD……………….# days per month that a very high (BG>300) is recorded
NLHD……………….#days per month that a hypo or a very high is recorded
PDIR……….% of days per month in which all BGs are in the target range
PDNE………………………………….% of days per month without BG extremes

Example of Log Book Data of a Person with T2 Diabetes

Results: In the table, measures were calculated from a patient who was checking 3 BGs per day. The average BG and projected A1C appear constant. The average fasting BG and SDF did not change monthly, but changes occurred in the SDNF, suggesting issues with the consistency of breakfast and lunch meals. Despite stability of A1C and average BG, the PDIR worsened from 52% in month 1 to 33, 39, and 23% in months 2, 3, and 4, respectively. This reflects changes that can be appreciated via visual inspection of the logbook..

Proposed Measures Applied to Log Book Data

Measure	Month 1	Month 2	Month 3	Month 4
Mean BG (mg/dL)	153	150	153	147
Projected A1C (%)	7.0	6.9	7.0	6.9
Mean fasting BG, SDF	127, 43	112, 37	125, 40	118, 41
Mean pre-lunch BG, SDNF	163, 60	154, 39	161, 56	159, 55
Mean pre-dinner BG, SDNF	174, 71	185, 43	173, 54	167, 53
NLD	2	2	0	1
NHD	1	0	0	0
NLHD	3	2	0	1
PDIR	0.52	0.33	0.39	0.23
PDNE	0.90	0.93	1.00	0.94

Conclusion: These proposed metrics provide insight to user BG data that go beyond measures of average. Digital health tools are capable of calculating these metrics and making them available for provider clinical decision support. Future studies will examine if these measures correlate with QOL or health outcomes.

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