Identifying Digital Health Habits
Correlated with Improved Blood Glucose Control

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Conflict of Interest Disclosures

- Coauthors Dr. Anand K. Iyer, Malinda Peeples, and Dr. Mansur Shomali are employees of Welldoc, Inc., creators of the BlueStar® digital health platform

- Center for Health Information and Decision Systems has received funding from Welldoc, Inc.

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Background

- Management of Type 2 diabetes is challenging for patients and requires careful attention to self-management behaviors including tracking of glucose, medications, food, activity, sleep and symptoms (Casagrande et al., 2013)

- Challenge is exacerbated by the lack of interaction beyond the doctor's office visit, which may occur only quarterly

- Clinically-validated digital health tools offer a promising solution to help patients achieve their diabetes management goals (Cui et al., 2016)

Research Gap

- Despite the intuitive promise of digital health, less research has been performed on identifying engagement with specific features and usage patterns that are critical to diabetes management success

- This research is especially critical given questioning of effectiveness of self-monitoring blood glucose (Malanda et al., 2012, Platt et al., 2019)

What digital health habits are associated with clinically meaningful improvements in blood glucose control?

Method

- Analyzed data of 397 users of BlueStar® (Welldoc Inc., Columbia, MD)

- FDA-cleared digital health solution for Type 2 Diabetes and RCT-tested (Quinn et al., 2008, 2011)

- BlueStar is a mobile and web platform that provides automated coaching messages (motivational, behavioral, and educational) to facilitate tracking and self monitoring of diabetes management based on real-time BG values and trends

- Users can log measures relevant to diabetes management such as BG readings, medication intake, exercise, sleep, and lab results, etc.
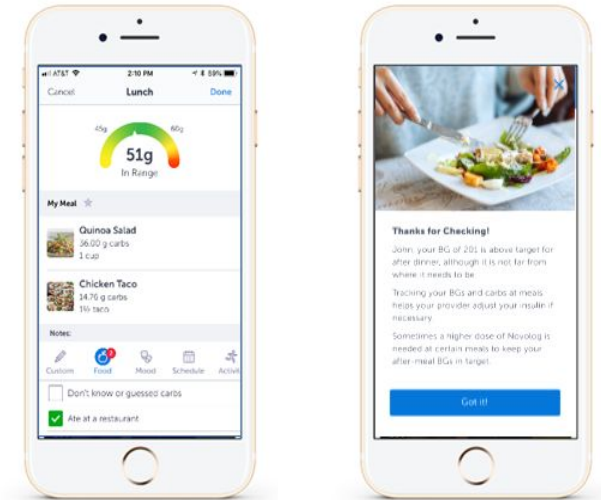
Figure 1. Sample screenshots of the solution.

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Sample Characteristics

- Inclusion criteria:

  - Users with Type 2 Diabetes who had at least one engagement with the solution

  - > 150 mg/dL average BG in first two weeks of engagement

  - No CGM use

- 45.1% male; M_{age} = 50.80, SD_{age} = 11.35

- $M_{BaselineBG}$ = 202.25, $SD_{BaselineBG}$ = 59.50

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Logistic Regression Analysis

- Predictors:

  - Engagement data from first 4 weeks

    - Standardized for ease of interpretation

  - Demographic characteristics

- Outcome: Clinically significant improvement in BG

  - Defined as a 14 mg/dL drop

    - Average BG_{Month1} – Average BG_{Month6}

    - Average Daily Maximum BG_{Month1} – Average Daily Maximum BG_{Month6}

Results

Variable	B	SE	OR	*p*
Male	0.43	.52	1.54	.40
Age	-0.01	.02	.99	.67
No Medication	0.44	1.54	1.55	.78
Non-Insulin Injectable	1.11	.98	3.03	.26
Long-Acting Insulin	1.55*	.73	4.70	.035
Short-Acting Insulin	1.02	.79	2.78	.20
Unknown Medication	0.58	.91	1.79	.52
Blood Glucose Entries	-0.09	.67	0.92	.90
Blood Pressure Entries	0.35*	.17	1.42	.04
Medication Entries	0.45*	.19	1.57	.02
Carb Entries	0.55*	.26	1.73	.04
Exercise Entries	0.29	.29	1.34	.32
Step Entries	-0.24	.44	0.79	.59
Sleep Entries	.09	.26	1.10	.73
Lab Entries	.02	.23	1.02	.93
Comment Entries	1.00	.34	1.10	.78
Weight Entries	0.03	.15	1.03	.85
Water Entries	0.11	.23	1.12	.63
Constant	-3.64**	1.30	0.03	.004

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Conclusion

- Digital health habits that requires active entry more strongly correlated with successful BG outcomes

- Engagement associated with behaviors critical to diabetes management are more predictive of success at six months

- Behaviours beyond just glucose measurement can provide valuable input for automated coaching that correlates the effects of those behaviors with BG outcomes

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Limitations and Future Directions

- Correlational data, need to tease apart causal mechanisms

- Rely on self-reported BG data for outcome

- Points to future directions for developing digital health-based scores for diabetes management behaviour

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