Hypoglycemia Prediction Using SMBG Data and Patient Medication Information

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Objective

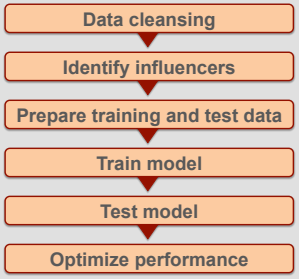
Hypoglycemia is a significant adverse outcome in patients with type 2 diabetes and has been associated with increased morbidity, mortality, and cost of care[1]. In addition, hypoglycemia is a major limiting factor for the optimization of insulin therapy. In patients with Type 1 diabetes, continuous glucose monitoring (CGM) is commonly employed, but most patients with Type 2 diabetes only check their glucose levels approximately one time per day. Our goal is to use self-monitored blood glucose (SMBG) to predict accurately an individual's risk for hypoglycemia the following day. Results could then trigger interventions through an automated mobile health (mHealth) coaching platform.

In our previous work[2], we trained models utilizing SMBG values alone. In the current study, we investigated whether a model which also utilized patient medication information would improve hypoglycemia forecasting.

Methods

A probabilistic model using machine learning algorithms[3] was trained using de-identified SMBG data from a randomized controlled trial[4]. For each data sample, 11 SMBG data points were used in the 7 days prior to a hypoglycemic event (defined as SMBG <70 mg/dL). The training data for the model also included medication information such as medication class (such as short-acting insulin, long-acting insulin, pre-mix insulin, oral agents) and drug dosage. Patient data without 11 or more medication administration entries in a given week were excluded from the training and validation data sets. Control samples used for training contained no hypoglycemia on the 8th day. The model was constructed to predict the hour of the occurrence of hypoglycemia. In order to validate the model after training, samples not used for training the model were presented to the model without the SMBG data from the 8th day. Sensitivity and specificity for predicting the hour of hypoglycemia or no hypoglycemia on day 8 were then calculated. Further validation was performed with another distinct data set.

Figure 1: Machine learning methodology



Results

Table 1: Comparison of Hypoglycemia Predication Models

	Sensitivity	Specificity	Prediction type
BG-Only Model [2]	91.7%	69.5%	24 hour forecast
BG + Medication Model	89.0%	92.1%	hour of the day

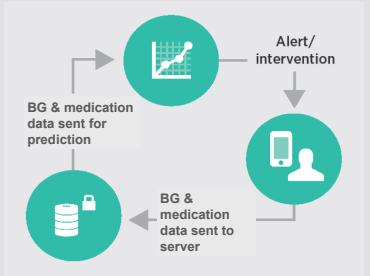
By adding medications to the SMBG-only model the specificity was significantly enhanced and the timeframe of predicting a hypoglycemia event was narrowed from the next 24 hours to a specific hour in the next 24 hours.

BG+Medication Model Performance

	Table 2: Data Set A Accuracy: 90.6%			Table 3: Data Set B Accuracy: 91.1%		
	hypo event	no hypo event	precision	hypo event	no hypo event	precision
predicted hypo event	227	20	91.9%	387	34	91.9%
predicted no hypo event	29	248	89.5%	41	377	90.2%
Recall	88.7%	92.5%		90.4%	91.7%	

Conclusions

- Hypoglycemia predication in type 2 diabetes can be **accurately predicted to within one hour** using medication data and SMBG values (occurring at a "real-world" frequency of ~1x/day).
- Medication information **increased specificity of the model by 32%**
- Further study should test the models when used in real-time
- An automated mHealth coaching platform could use the model's predictions to provide interventions and education to manage or prevent hypoglycemia



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