HEADWIND: Design and Evaluation of a Vehicle Hypoglycemia Warning System in Diabetes - a proof of principle study

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Publication date:
2019-11-14

Permanent link:
https://doi.org/10.3929/ethz-b-000368538

Funding acknowledgement:
183569 - Design and Evaluation of a Vehicle Hypoaglycemia Warning System in Diabetes (HEADWIND Project) (SNF)

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Background/Introduction:

Despite ongoing developments in the treatment of diabetes, hypoglycaemia remains one of the most relevant acute complications associated with this disease. During hypoglycaemia cognitive, executive and psychomotor abilities significantly deteriorate. Accordingly, hypoglycaemia has consistently been shown to be associated with an increased risk of driving accidents and is, therefore, regarded as one of the relevant factors in traffic safety. Today's cars continuously gather a broad spectrum of real-time information on various driving parameters. This may allow for an alternative approach to the problem of hypoglycaemia during driving. Using artificial intelligence constantly analyzing driving behavior it may be possible to timely detect changes in driving pattern characteristic for driving in hypoglycaemia. Based on these alterations in driving variables we aim at establishing algorithms capable of discriminating eu- and hypoglycemic driving patterns using artificial intelligence.

Methods:

In a proof of principle study we compared data regrading driving behavior of 5 individuals (3 non-diabetic and 2 with type 1 diabetes) tracking measurements in eu- and hypoglycemic condition while driving on a predefined route using a professional driving simulator (Carnetsoft BV). Over 60 driving parameters were assessed at a sampling rate of 30 Hz. Time series of car-based sensor data was then sliced into 5 minute windows and random forest machine learning classifier as well as deep neural networks were applied to build a system detecting hypoglycemia within 5 minute frames.

Results:

Car-based data provided 73'970 measurements in hypoglycemic condition (<3.9mmol/L) and 110'959 samples in euglycemic condition (4.0-10mmol/L). A simple linear logit model was used for reasons of interpretability, which confirmed statistical significance of key variables (e.g. "velocity" and "steering speed") at the 1% level. 1-fold cross-validation on subject level (i.e. training the model on all subjects except for one, which is used for testing and repeat this until every subject has been in the testing set) using random forest from machine-learning and deep neural networks, applied because of the highly non-linear relationship resulted in a ROC-AUC in hypoglycemia prediction of 0.72 and 0.74, respectively.

Conclusion:

Our preliminary evaluation applying machine learning models on driving simulator based data show between-subject predictability of hypogylcemia even in a small dataset. This confirms the effectiveness of artificial intelligence in hypoglycemia detection while driving and may represent a promising novel approach to increase traffic safety in patients suffering from diabetes.

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Self declaration of category:	☐ basic-experimental	☒ clinical
Asemo:	☐ yes	☒ no
Status of first author:	☐ student	☒ no student