Automatic detection of mealtime situations in daily regimen of patients with Type 1 diabetes who use mHealth technologies

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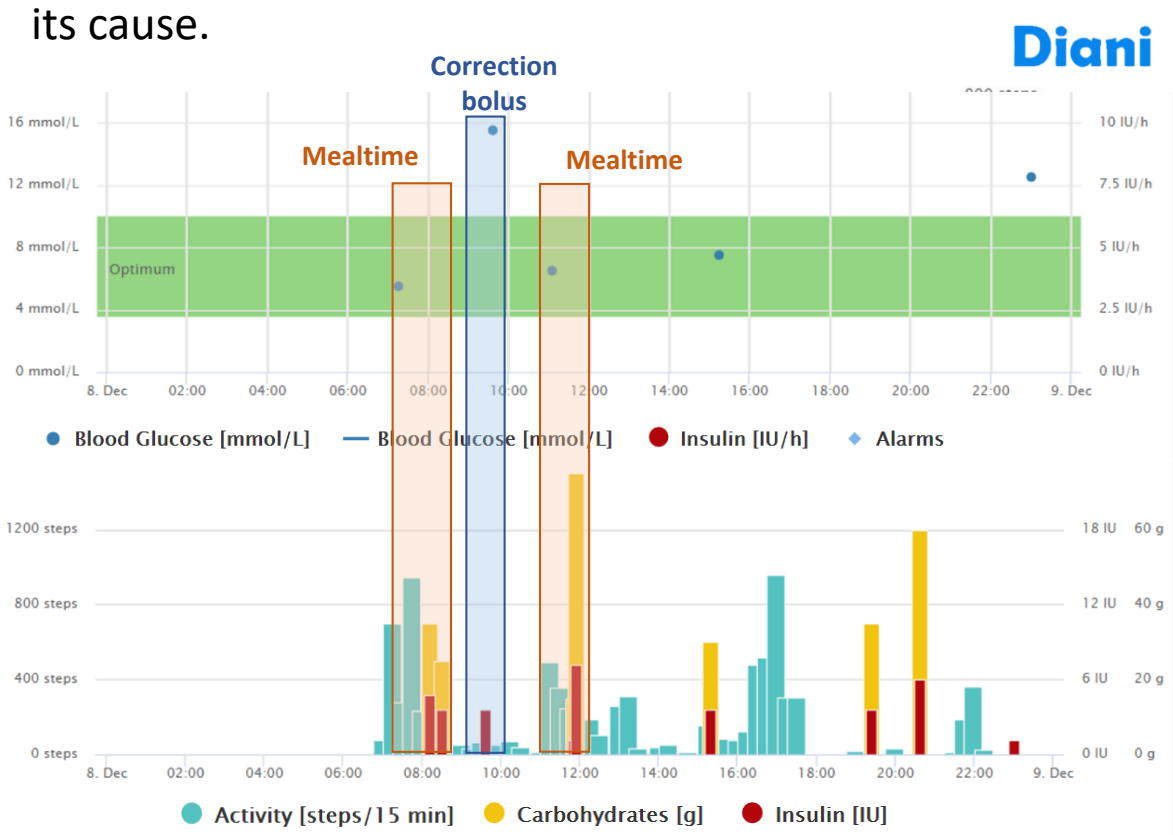
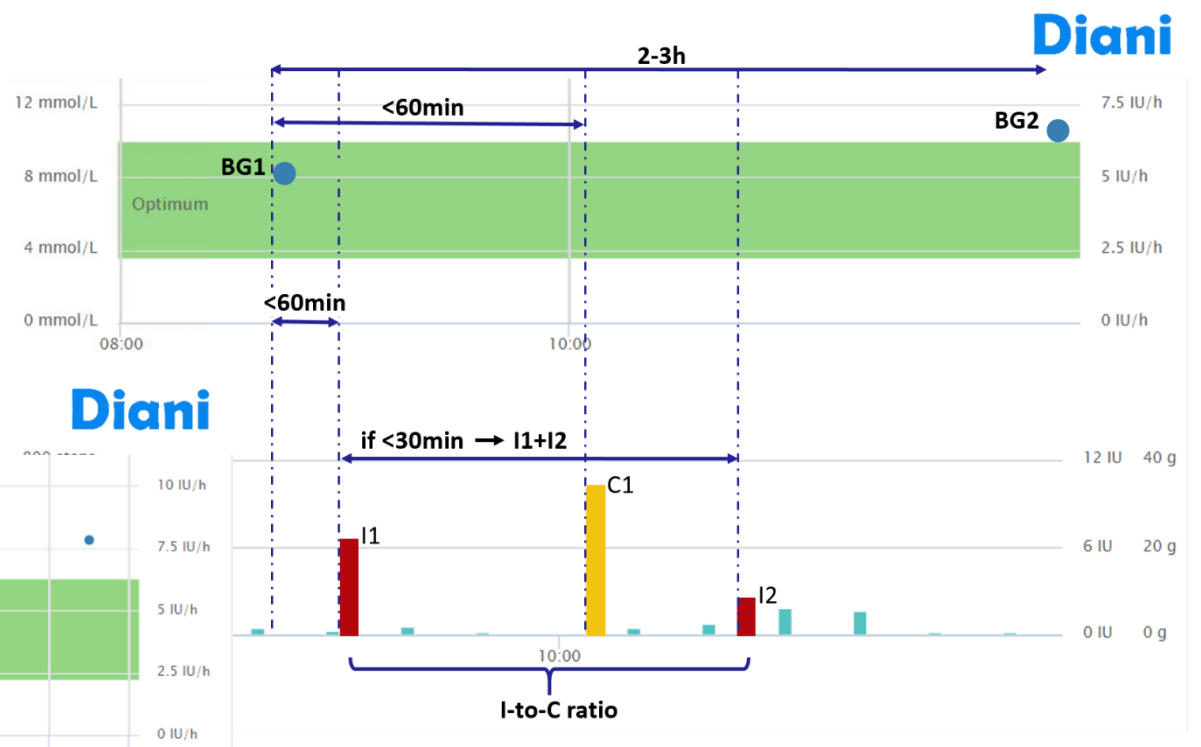
Introduction

Mobile health technologies enable recording, tracking, and analysis of daily health-related data registered by patients with Type 1 diabetes. Studying this data, i.e. 1) understanding relations between blood glucose and the other parameters which have an impact on its value (such as time and amount of carbohydrate intake, applied insulin doses or intensity and duration of physical activity) and 2) studying how the data are registrered by patients using certain mHealth device, can help to build algorithms capable of automatically searching for problematic situations in patients' daily regimens.

Methods

Glycaemia, carbohydrate intake and insulin doses, were registered in a diabetes diary app by T1D patients (n=4, 3-18months) and used to create algorithms intended to automatically identify mealtime glycaemia and if being out of range, make conclusion of its cause.





Based on BG value, insulin-to-carbs ratio calculated from detected insulin and carb doses, and time of registrations lead to conclusion of, for example, carbs counting fail, too much/too less insulin dose, or missing registrations. Conditions for detecting correction bolus were also implemeted.

Results

In order to investigate whether the situations detected by the algorithms were assigned correctly and deduced relevant conclusions about patient´s problematic days, one diabetologist manually evaluated data from 4 selected patients based on his professional medical opinion.

From the 3-day samples, the algorithms detected an average 14±0.7 mealtime glycaemia situations per patient. The algorithms classified the out-of-range mealtime glycaemia as the results of either "carb-counting mistakes/missed registrations" (n=12) or "inappropriate correction boluses" (n=12). Two hypoglycemic events identified by the clinician were not detected by the algorithm as "mealtime glycaemia situations".

Time	Glycemia (G) Carbs(C) Insulin (I)	Value G [mmol/L] C [g] I [IU]	Clinician´s Evaluation	Algorithm´s Evaluation	Numbered Excursions	Comments
Day 1						
6:47	**G**	4.4	**NA**	**In range Fasting BG In range**	**1**	The clinician´s notes on this day were: "*Optimal glycemia + one "mistake". Based on the execusion, and since no other data are available, I would say that it must have been a mistake related to carbs counting*". The algorithm detected the same situation with similar evaluation (#3), whereas the the optimal glycemias are interpreted with their correct classification
6:47	C	30				
7:07	I	3				
12:32	**G**	6.7	**NA**	**In range**	**2**	
12:34	C	35				
12:34	I	3.5				
12:54	C	20				
12:54	I	2.5				
14:33	**G**	12	**High** **Bad Carbs Counting**	**High** **Mistake in Carb Counting/Missed registration**	**3**	
14:34	I	1				
15:01	C	8				
15:01	I	0.5				
18:21	**G**	7.5	**NA**	**In range**	**4**	
18:27	C	30				
18:27	I	4.5				
18:43	C	8				
18:44	I	0.5				

Tab 1: comparison of the clinician´s comments with the algorithms´ deduction from the information available

Conclusion

Patient-registered data can be used to develop algorithms to automatically detect issues within patients' self-management decisions. However, additional testing and refinement of the algorithms' functionalities is needed, as well as more extensive and clinician-supported validation. The algorithms are going to be implemented to the Diani web application and further extended to physical activity and its relation to glycaemic variability.

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