In Silico Assessment of Literature Methods to Adjust Insulin Bolus Dose according to CGM Trend

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Objective:
Continuous Glucose Monitoring (CGM) devices have been recently approved by FDA to be used in the type 1 diabetes (T1D) treatment non-adjunctively, i.e. without confirmatory fingerstick (SMBG) measurements (Edelman, JDST, 2017). Consequently, how to tune insulin bolus relying also on glucose rate of change (ROC), has become of particular interest. Our aim is to evaluate extensively in silico empirical literature methods proposed for such a scope.

Method:
The UVa/Padova T1D Simulator was expanded using the decision making model reported in (Vettoretti, 2ndrev. IEEE TBE, 2017) to simulate 100 virtual patients in single-meal, noise-free scenarios with different preprandial BG and ROC. Standard performance metrics, i.e. percentage of time spent in hypoglyceamia (T_{HYPO}), hyperglyceamia (T_{HYPER}) and euglycemia (T_{EU}), were used to compare a reference situation, i.e. bolus dose calculated using SMBG only, with three literature methods, i.e. (Scheiner, ADA, 2015), (Pettus, JDST, 2017) (Buckingham, PD, 2008).

Results:
When ROC is negative, the Pettus and the Buckingham methods obtained better results in terms of T_{EU} and T_{HYPO}. When ROC is positive, the Pettus and the Buckingham methods obtained better T_{HYPER}, while the best T_{EU} and T_{HYPO} values were obtained using the reference and the Scheiner method. Furthermore, we found that for positive ROC and high preprandial BG values the scenario is very challenging: the reference and the Scheiner methods strongly prevail on the others, keeping T_{HYPO} almost to zero.

Conclusion:
A preliminary assessment of literature methods for insulin bolus dose adjustment using ROC has been made. Results strongly depend on the pair (BG,ROC) at mealtime. None of the methods clearly outperforms the others. Still, further investigations seem needed to optimize insulin therapy using CGM trend.