ISSN 2450–7458
e-ISSN 2450–8187

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Effects of Diabetes Technologies on Decision Making Feedback Loop in Type 1 Diabetes

To the Editors,

People with type 1 diabetes make nearly 180 diabetes-related decisions every day [1]. Understanding the causality between diabetes-related decisions and their effect on glucose levels is crucial in diabetes management. People's knowledge, comprehension, motivation, and predictions shape these decisions which are improved through deductions from past experiences. The contribution of diabetes technologies to decision-making in diabetes management is modeled in this letter.

Glucose-affecting inputs and outputs are shown in Figure 1. While these inputs can directly or indirectly affect glucose levels, inputs' timing and extent differ. Moreover, their combinations complicate understanding their effect on glucose levels and the causality in between. Inputs are evaluated by people with type 1 diabetes or their caregivers based on the evaluator's education, knowledge, comprehension, and experiences. The evaluation is followed by a decision and action that affect glucose levels and produce an output. The outputs are observed as symptoms of acute complications (hypoglycemia or hyperglycemia) or self-measurements [continuous glucose monitoring (CGM) or fingerstick (SMBG, *self-monitoring of blood glucose*)] in the short-term, as A1c in the medium-term (three months), as markers of chronic complications such as nephropathy, retinopathy, neuropathy in the long-term. These outputs provide feedback in different resolutions to people with type 1 diabetes, their caregivers, and diabetes teams. Medium or long-term outputs are not influenced by a single input but by a combination of many over time. Thus, medium- and long-term outputs cannot identify the causative input due to their insufficient resolution to distinguish. However, short-term outputs provide better resolution since they are affected by fewer inputs. For example, a high A1c may be due to insufficient basal insulin and a stressful and sedentary work environment. However, an increase in glucose level in 30 minutes may be explained by carb intake without insulin administration alone. Before the introduction of CGM, conventional outputs were SMBG (5–10 times a day) and A1c (Fig. 2). Although SMBG's discrete glucose values provide enough resolution to address the consequences of specific inputs like meals, these data cannot show the course of the inputs' effect on glucose levels. CGM overcomes this problem by providing glucose levels every minute [2]. Thus, the onset, duration, intensity, and acceleration of inputs' effect on glucose course can be observed longitudinally. These additional parameters also enhance the feedback. The increased frequency of feedback allows people to interact with their management more frequently, thus providing more experience, opportunities for self-education, a better assessment and forecasting. Each loop is an opportunity to improve diabetes management by evaluating the inputs and output, determining new strategies through deductions.

Automated insulin delivery systems (AID) are designed to evaluate the outputs of CGM and automate

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Clinical Diabetology 2023, 12; 1: 71–73
DOI: 10.5603/DK.a2022.0065
Received: 22.11.2022 Accepted: 26.11.2022

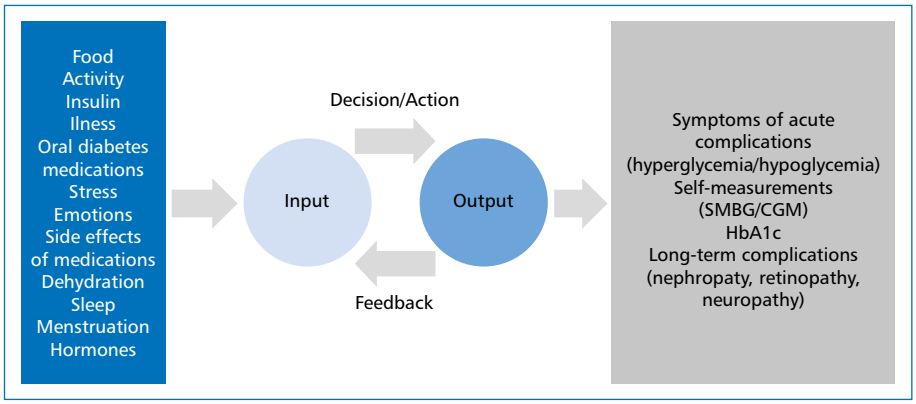

Figure 1. Decision Feedback Loop in Diabetes Management
Inputs are recognized by the evaluator who make a decision and take an action accordingly. Decisions and/or actions affect glucose levels and produce an outcome. Recognized outcomes are assessed and produce feedback to link the causality between input-driven decision/actions and outputs.
CGM — continuous glucose monitoring; HbA1c — glycated hemoglobin; SMBG — self-monitoring of blood glucose

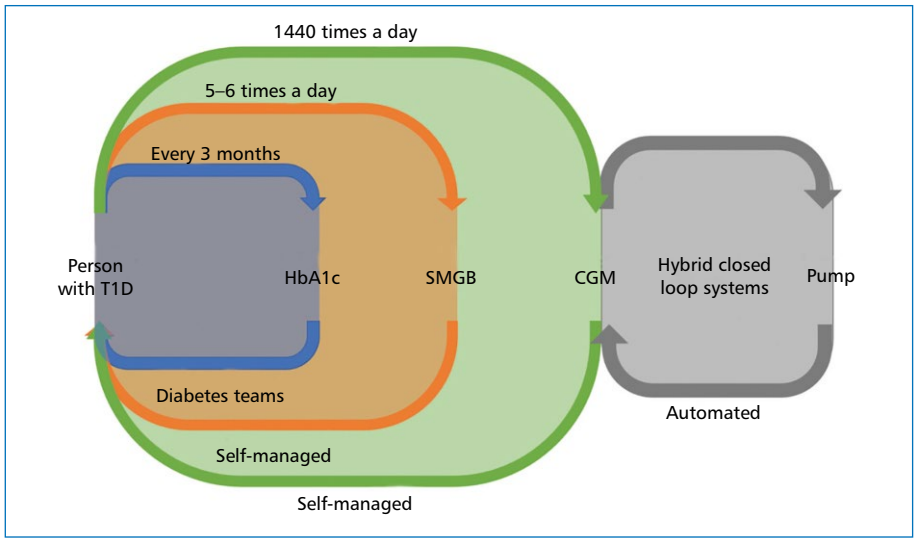

Figure 2. Frequency of Outputs
Glycated hemoglobin (HbA1c) are evaluated every 3 months by diabetes teams. Self-monitoring of blood glucose (SMBG) assesses the output 5–6 times a day. Continuous glucose monitoring (CGM) produces output up to 1440 times a day. Hybrid closed loop systems provide automated insulin delivery through its algorithm, independently from the user except the meals

insulin delivery through algorithm-driven insulin inputs. It reduces the need for personal assessment and decisions for most inputs except meals. Although the reduced burden and improved glycemic control make AID desirable for diabetes management, the reduced need for human involvement may lead to less interaction of someone with his diabetes, thus, less deduction and less experience. However, AID still cannot provide the desired glycemic control alone [3] and we cannot exclude the human factor.

Ethical approval

Ethical approval was not necessary for the preparation of this article.

Funding

This publication was prepared without any external source of funding.

Conflict of interest

None declared.

REFERENCES

1. Digitale E. New research shows how to keep diabetics safer during sleep. 2014. . https://scopeblog.stanford.edu/2014/05/08/new-research-keeps-diabetics-safer-during-sleep/ (22.11.2022).
2. Black E. Abbott has a new glucose monitor for diabetics — It's so small I forgot I was wearing it. 2022. https://www.cnbc.com/2022/10/14/review-abbott-freestyle-libre-3-cgm-for-diabetics-.html (22.11.2022).
3. Akturk HK, Snell-Bergeon J, Shah VN. Efficacy and Safety of Tandem Control IQ Without User-Initiated Boluses in Adults with Uncontrolled Type 1 Diabetes. Diabetes Technol Ther. 2022; 24(10): 779–783, doi: 10.1089/dia.2022.0162, indexed in Pubmed: 35714344.