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Application for Accu-Chek® SmartGuide Predict app

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1 Category

Best Digital Health Solution

2 General Information

Company Name	Roche Diagnostics International AG, Basel Branch Diabetes Care
Number of employees	> 1000
Product/Solution Name	Accu-Chek® SmartGuide Predict app
Indications	Adults with type 1 or type 2 diabetes on flexible insulin therapy
Therapeutic Areas	Diabetes self-management and decision support
Trade Name	Accu-Chek® SmartGuide Predict app
Approval date	Feb. 28th, 2024, declared and CE-marked as compliant to EU MDR EC 745/2017 regulation

3 Background information and need for device

Diabetes is one of today's major healthcare challenges and is growing rapidly. 537 million adults were living with diabetes in 2021 and by 2045 this is expected to increase to an estimated 783 million people, globally. The International Diabetes Federation (IDF) estimates that this chronic condition was responsible for 6.7 million deaths in 2021 and diabetes is the top cause of adult blindness, kidney failure, and lower-limb amputations [**IDF Diabetes Atlas, 2021**].

Despite huge investment and significant progress in diabetes treatment and management over the past decades, only about 7% of people with diabetes (PwDs) currently achieve their therapy goals, leading to the aforementioned long-term complications **[IDF Diabetes Atlas, 2021]**.

Most day-to-day therapy decisions, like insulin dosing, are made by PwDs on their own. These therapy decisions are prone to errors, as they are based on retrospective information and unknown future glucose trends. Moreover, for PwDs, maintaining blood glucose levels within the recommended target range and preventing adverse glycemic episodes can be a daunting task, requiring up to 180 decisions throughout the day **[Erin Digitale Scopeblog Stanford]**.

Continuous glucose monitoring (CGM) has revolutionized modern diabetes management and is now widely regarded as the gold standard for glucose monitoring for PwDs on insulin therapy, offering real-time data and a comprehensive understanding of glucose fluctuations **[Maiorino et al., 2020]**. Despite the clear association between CGM usage and improved glucose control, there is still a significant proportion of PwDs who do not achieve glycemic targets even with CGM **[DeSalvo et al., 2023]**. In addition, PwDs commonly experience an average of two hypoglycemic events per week, with 1-2 severe episodes annually requiring medical intervention and, in extreme cases, can even result in fatal consequences **[Mellor et al. 2024]**. Notably, hypoglycemia, particularly during nighttime, has been linked to a decrease in quality of life, heightened anxiety, fear, and diminished productivity **[Chatwin et al., 2023]**. It is important to acknowledge that fear of hypoglycemia and diabetes distress persist among PwDs utilizing CGM technology, which has been associated with elevated glucose levels **[Nagel et al., 2021]**.

CGM has also been crucial for the development of automated insulin delivery (AID) systems. However, while AID has been proven effective in improving glycemic outcomes, it is widely acknowledged that it may not be suitable for all PwDs. Patients may face several hurdles such as eligibility criteria defined by the healthcare provider, the need to carry multiple medical devices (CGM, insulin pump, controller), a lack of trust in the system, complexity of use, and its elevated cost for both the user and healthcare provider **[Marigliano et al., 2023]**. Hence, there is an urgent need to make CGM data more meaningful and actionable for the user by providing user-friendly and intelligent technology that instills confidence in improved glucose control. Most existing CGM digital companions only offer visualizations of past and present CGM values, which limits their utility to reactive management of glucose levels. To better serve PwDs, it is crucial to provide them with solutions that enable a more proactive and data-driven approach. This can be achieved by enhancing such solutions with glucose-predictive capabilities **[Ehrmann et al., 2024]**.

Despite numerous research efforts in developing glucose prediction technologies, the availability of commercial solutions incorporating this functionality remains very limited **[Fleming et al., 2020]**.

The **Accu-Chek® SmartGuide Predict** app bridges this gap by integrating state-of-the-art AI-enabled glucose predictive capabilities, while maintaining an intuitive user interface that effectively communicates the user's past, current, and forecasted glycemic status **[Herrero et**

al., 2024]. Three distinct predictive features developed with machine learning are enabling this shift towards personalized preventive glucose management in the app:

- **Glucose Predict:** a continuous forecast that visualizes glucose levels over the next 2 hours, allowing for continuous anticipation of potential adverse glycemic events;
- **Low Glucose Predict:** a continuous watch-dog for hypoglycemia, warning the PwD up to 30-min before a hypoglycemic event occurs;
- **Night Low Predict:** a night guardian, estimating the risk of hypoglycemia during the 7-hour night before the PwD goes to bed, to inform if any preventive measures, such as eating a bedtime snack, should be considered before falling asleep.

The **Accu-Chek® SmartGuide Predict** app is one part of the overall **Accu-Chek® SmartGuide CGM** solution, to be launched in 2024 in selected European countries.

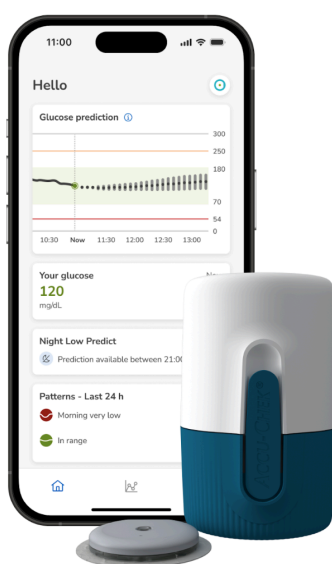


Figure 1. The **Accu-Chek® SmartGuide CGM** solution encompasses the **Accu-Chek® SmartGuide Predict** app along with the **Accu-Chek® SmartGuide** sensor (Accu-Chek SmartGuide sensor is pre CE mark. Not available for sale.)

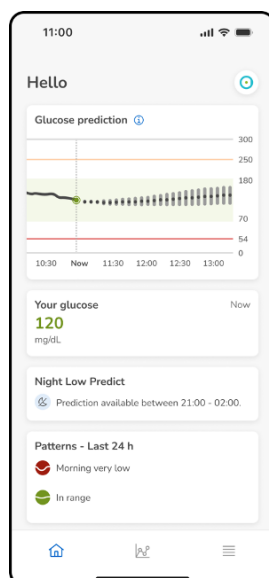


Figure 2. Main **Accu-Chek® SmartGuide Predict** app screen displaying the Glucose Predict functionality (top graph) including the predicted glucose values (dotted line) accompanied by their corresponding error bounds (gray error bars).

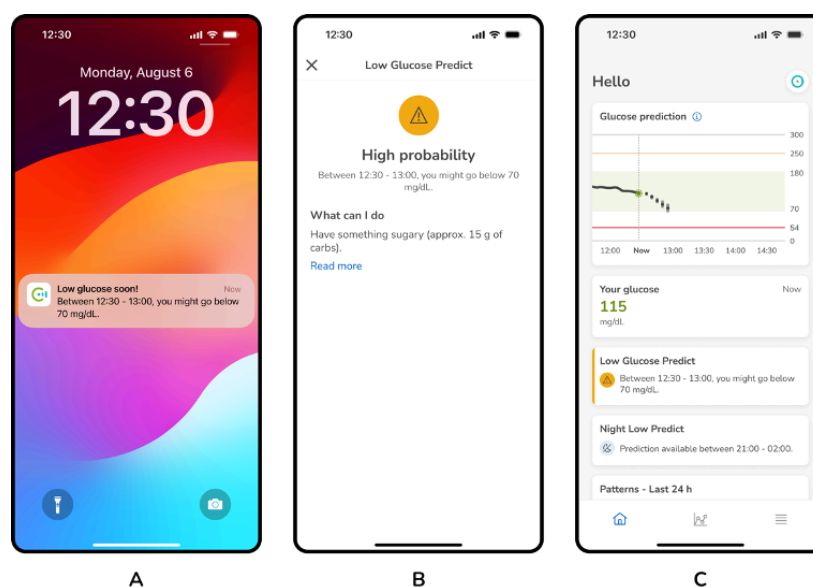


Figure 3. **Accu-Chek® SmartGuide Predict** app screenshots of the Low Glucose Predict functionality, featuring: A) push notification indicating a risk of low glucose within the next 30 minutes. B) Screen indicating possible actions to minimize the risk of low glucose within the next 30 minutes. C) Main **Accu-Chek® SmartGuide Predict** app screen showcasing a card indicating a risk of low glucose within 30 minutes.



Figure 4. Accu-Chek® SmartGuide Predict app screenshots of the Night Low Predict functionality, featuring: A) push notification indicating a high risk of glucose levels dropping below 70 mg/dL between 22:30 and 02:00. B) Dedicated screen presenting the predicted risk in a gauge format that is displayed when requesting the triggering of the Night Low Predict functionality or pressing at the push notification. C) Main **Accu-Chek® SmartGuide Predict** app screen showcasing a card indicating high risk of a night low glucose.

4 History of the development of the product

2016 - User needs study

In order to fulfill our vision of providing peace of mind and genuine relief to people with diabetes (PwDs), we adopted a user-centric design approach. For this purpose, we conducted an extensive study to understand the needs of our users and identify potential opportunities for a smart digital companion app.

2017 - Data gathering

It was clear that any development of the identified companion app features would need a high-quality set of clinical as well as contextual data from PwDs, which was up to this point not readily available. Therefore, a multi-center two-month clinical study was conducted with over 200 subjects. During the study, subjects were asked to wear a continuous glucose monitoring device and a fitness tracker. Additionally, the subjects had to log their carbohydrate and insulin intakes into a diary app and were examined at the hospital at regular intervals.

2018 - Development and pilot study

Based on this comprehensive set of clinical and contextual data collected in the previous phase, a smartphone app prototype was developed, featuring an initial version of two of the current features: Glucose Prediction and Night Low Predict. This prototype was subsequently tested in

a pilot study with more than 100 CGM users to confirm that the features are addressing PwDs' needs.

2020 to 2024 - Software as a medical device development, certification, and launch

Based on the success of the pilot study, the decision was made to start the development of the full-fledged smartphone application under the medical device regulation adding a third feature: "Low Glucose Predict" along the way. Key steps were the integration of the state-of-the-art machine learning models into the medical product. To satisfy the regulatory needs, the algorithms were embedded in a system of safeguards to ensure patient safety during day-to-day use. In addition, multiple user tests were employed to optimize the patient-user interface, making the predictions accessible and relevant.

To show the consistency of the performance and the clinical value of our solution, we evaluated the prediction accuracy of all three features on different cohorts of PwDs on different insulin therapies [Herrero et al., 2024]. It has been shown that across different types of diabetes and different therapy settings, the algorithm performance is among the best in class:

- The continuous glucose prediction even after 2 hours exceeds 96% of sample assignment to the zones A&B of the Parkes error grid [Parkes et al., 2000].
- Short-term hypoglycemia detection in the next 30 min shows a sensitivity of 95.2% and a specificity of 98.9%.
- Nighttime hypos can be detected with an accuracy of 86.5%.

Furthermore, in-silico trials were conducted simulating the use of the **Accu-Chek® SmartGuide Predict** app to elicit the potential clinical benefit. The employed FDA-accepted simulator leverages a state-of-the-art in-silico population to evaluate the impact of user behavior interventions on the blood glucose level [Glatzer et al 2024] to simulate the impact of user behavior on the blood glucose level. The simulation showed that by using the app, time in hypoglycemia is reduced by up to 47% compared to standard of care.

Both validation approaches together with the summative user study are supporting the promise of major improvements in diabetes management and quality of life.

The full system was first presented to the public at ATTD 2024, one of the major global diabetes technology conferences, and triggered excitement in the diabetes community.

5 Why this device is innovative, the broad implications for future research, and/or how it will improve the human condition

Why is our product innovative?

By harnessing the latest advancements in data science and usability engineering, the **Accu-Chek® SmartGuide Predict** app represents a remarkable development in diabetes management. Providing a suite of advanced glucose predictions, this transformative application empowers users with unparalleled insights and actionable information. It not only enhances the

utility of CGM data but also enables a proactive approach to disease management, marking a significant milestone in healthcare innovation.

How will our product improve the human condition?

From the time of diagnosis, diabetes is a life-long disease. Despite the effectiveness of CGM in diabetes management, a significant number of people with diabetes (PwDs) still struggle to achieve glycemic targets. The **Accu-Chek® SmartGuide Predict** app provides users with multi-horizon glucose predictions enabling them to be a step ahead of their glucose excursion during the day and throughout the night. Being a step ahead of glucose excursions enables a shift in paradigm on how CGM technology is applied to improve glycemic control in the future. Proactive diabetes management based on predictions allows for the prevention of unwanted glucose events rather than only reacting after the complication occurs. On the one hand, avoiding glucose excursions before they happen results in an improvement of glycemic control, addressing the risk of diabetes-related complications. On the other hand, less critical glucose events reduce the alarm frequency, a known burden of current CGM users, and a source of diabetes stigma. Glucose predictions have been demonstrated to reduce diabetes distress and fear of hypoglycemia which are currently impacting the quality of life of many PwDs. **[Ehrmann et al. 2024]**

What are the broad implications for future research?

The **Accu-Chek® SmartGuide Predict** app is a stepping stone to even more personalized algorithms that can leverage the individualities and context of each patient in the future. Every PwD is different and needs a tailored solution to their unique lifestyle. Sport, stress, sleep quality, diet, and many other factors from daily life can influence glucose levels of patients, thus it is paramount to have a tool that can capture the patterns of these changes. Our product showcases the importance of research and development in delivering real-time decision-support tools that help patients struggling with chronic diseases. Other disease areas can also benefit from this companion technology and utilize it to monitor chronic patients and support them with therapy recommendations.

6 References

Product related references

Patents/Designs:

- US2023/17080 Predicting Glucose Values
- US2023/0092186A1- Machine learning based prediction of glucose levels over a time course
- WO2022/219042A1 Postprandial blood glucose level prediction

- WO2018149872A1 Display of glucose event patterns
- US7650244B2 Determining progression of glucose levels
- EU Design 015052403-0001 - Predict app night time predict GUI
- EU Design 015052040-0001 - Predict app short term predict GUI
- EU Design 015052385-0001 - Predict app GUI icon

Peer-reviewed Journal Publications:

- Herrero P, Andorrà M, Babion B, Bos H, Koehler M, Klopfenstein Y, Leppäaho E, Lustenberger P, Peak A, Ringemann C, Glatzer T. **Enhancing the capabilities of continuous glucose monitoring with a predictive app.** Journal of Diabetes Science and Technology. 2024. Accepted.
- Glatzer T, Gehr B, Ehrmann D, Onvlee J, Penalba M, Bucklar G, Hofer M, Stangs M, Wolf N. **Clinical usage and potential benefits of a CGM predict app.** Journal of Diabetes Science and Technology. 2024. Accepted.
- Ehrmann D, Laviola L, Priesterroth LS, Hermanns N, Babion N, Glatzer T. **Fear of hypoglycemia and diabetes distress: Expected reduction by glucose prediction.** Journal of Diabetes Science and Technology. 2024. Accepted.
- Mader J, Waldenmaier D, Mueller-Hoffmann W, Mueller K, Angstmann M, Vogt G, Rieger C, Eichenlaub M, Forst T, Freckmann G. **Performance of a novel continuous glucose monitoring device in people with diabetes** Journal of Diabetes Science and Technology. 2024. Submitted.

Abstracts/Posters:

- Ringemann C, Duke D, Kösters U, Klopfenstein Y, Lustenberger P, Petersen B, Wörner T. **Real-world validation of a smartphone app featuring blood-glucose prediction algorithms from continuous glucose monitoring data.** European Association for the Study of Diabetes (EASD) annual conference. September 2020, Barcelona, Spain. [Abstract # 786](#)
- Herrero P, Andorrà M, Babion B, Bos H, Koehler M, Klopfenstein Y, Leppäaho E, Lustenberger P, Peak A, Ringemann C, Glatzer T. **Empowering CGM Users with Multi-horizon Glucose Forecasting Capabilities—The Accu-Chek SmartGuide Predict App.** American Diabetes Association's 84th Scientific Sessions. Orlando, USA, June 2024, Poster: 997-P. Accepted.
- Herrero P, Andorrà M, Babion B, Bos H, Koehler M, Klopfenstein Y, Leppäaho E, Lustenberger P, Peak A, Ringemann C, Glatzer T. **Enabling continuous glucose monitoring users with multi-horizon glucose predictive capabilities: the Accu-Chek® SmartGuide Predict App.** European Association for the Study of Diabetes (EASD) annual conference. September 2024, Madrid, Spain. Abstract number: 1339. Accepted.

Conference Presentations:

- **Presentation of the Accu-Chek® SmartGuide solution** at a symposium organized by Roche at 17th International Conference on Advanced Technologies and Treatments for Diabetes. March 2024, Florence, Italy.
- **Presentation of the Accu-Chek® SmartGuide solution** at the scientific sessions of the Spanish Society for Diabetes congress (SED 2024). April 2024, Granada, Spain.

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