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Published in:

Proceedings of the 18th Scandinavian Conference on Health Informatics

DOI (link to publication from Publisher):

[10.3384/ecp187034](https://doi.org/10.3384/ecp187034)

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Publication date:

2022

Document Version

Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Thomsen, C. H. N., Hangaard, S., Kronborg, T., Vestergaard, P., Hejlesen, O., & Jensen, M. H. (2022). Time for using Machine Learning for Basal Insulin Dose Guidance for People with Type 2 Diabetes? Preliminary Results from a Systematic Review. In *Proceedings of the 18th Scandinavian Conference on Health Informatics* (pp. 206-207). Linköping University Electronic Press. <https://doi.org/10.3384/ecp187034>

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Time for using Machine Learning for Basal Insulin Dose Guidance for People with Type 2 Diabetes?

Preliminary Results from a Systematic Review

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Abstract

The present systematic review aims to provide an overview and categorization of dose guidance methods that support basal insulin titration for people with type 2 diabetes. At the time of writing, quality assessment of the included articles is ongoing.

Keywords

Type 2 Diabetes, dose guidance, basal insulin, systematic review

1 INTRODUCTION

Optimal glycaemic control in people with type 2 diabetes (T2D) is crucial to prevent diabetes-related complications [1]. In many cases, treatment with basal insulin is necessary 5-10 years after diagnosis to reach glycaemic targets [2]. Titration of insulin to determine the optimal dose is a difficult and time-consuming task associated with clinical inertia [3]. Thus, 60% of people treated with insulin do not reach glycaemic targets [4].

In recent years, the development of dose guidance to support insulin titration has been of rapidly growing interest. Despite this rapidly growing interest and the fact that it has been a field of interest for several decades, no systematic review within the area has been found. Therefore, this systematic review aims to provide an overview and categorize dose guidance methods that support basal insulin titration of people with T2D by characteristics, effect, and user experience.

2 METHOD

The present systematic review will be reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines [5]. The review is registered at PROSPERO, an international prospective register of systematic reviews, as ID number CRD42021289364 [6].

The review considers studies that include adult (>18 years) subjects with a diagnosis of T2D treated with basal insulin alone or in combination with oral antihyperglycemic agents. Studies that evaluate dose guidance methods for basal insulin titration are considered. Furthermore, any outcomes related to glycaemic control and in any setting (e.g. general practitioners, the patient's home, and specialized diabetes units) are considered. An exhaustive search was performed in PubMed, Embase, Scopus, and

IEEE. Primary peer-reviewed full-text studies in English, Norwegian, Danish, and Swedish were screened for inclusion except for animal studies, expert opinions, and case studies. Data extraction will include study population, study design, method used for dose guidance, setting, study length, and reported outcome. Quality assessment of the included studies will be done using Joanna Briggs Institute's critical appraisal tools in accordance with the study design of the included studies [7].

3 RESULTS

The systematic search identified 4,245 potential studies in the selected databases. After the removal of duplicates, 3,211 studies remained. Following the screening of title and abstract, 270 potential studies were selected for full-text screening, which resulted in the inclusion of 32 studies. Citation and reference search was performed based on the 32 included studies. This led to the inclusion of 4 additional studies, which resulted in a total of 36 included studies. An overview of the study designs of included studies is shown in table 1.

Study design	Frequency
Randomized controlled trial	21
Quasi-experimental study	6
Simulation study	4
Mixed method study	3
Cohort study	1
Qualitative study	1

Table 1 is an overview of the study designs of the 36 included articles.

Preliminary results show the use of paper-based titration algorithms, telehealth solutions, and mathematical models in basal insulin dose guidance for people with T2D.

The 18th Scandinavian Conference on Health informatics, Tromsø, Norway, August 22-24, 2022. Organized by UiT The Arctic University of Norway. Conference Proceedings published by Linköping University Electronic Press at <https://doi.org/10.3384/ecp187>. © The Author(s). This work is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/>

Telehealth solutions cover digital implementation of a paper-based titration algorithm, shared decision-making platforms, and communication platforms between health care providers and people with T2D.

Figure 1 shows the percentwise distribution of the methods for basal insulin dose guidance identified in the included studies.

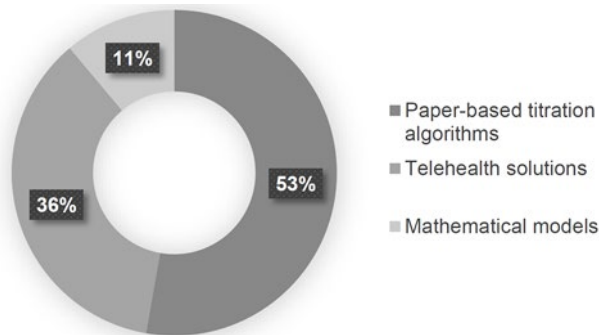


Figure 1 shows the distribution of methods used for basal insulin dose guidance identified in the included studies.

Among these identified methods for basal insulin dose guidance, both solutions aimed directly at people with T2D, and healthcare professionals are found. Though the majority of the methods are aimed at healthcare professionals.

At the time of writing, quality assessment of the included studies is ongoing.

4 DISCUSSION

The systematic review is strengthened by the broad scope since various dose guidance methods, outcomes, settings, and study designs are considered. However, this may complicate the comparison of the studies due to heterogeneity.

Based on the preliminary results, the majority of studies investigate non-technical basal insulin dose guidance in the form of paper-based titration algorithms. The use of digital solutions for basal insulin dose guidance is limited to simple telehealth solutions and one instance of a mathematical model embedded in a digital solution.

In recent years, mathematical models in the form of compartment models and recursive least square-based extremum seeking control methods have been investigated for basal insulin dose guidance for people with T2D, but the research is still very limited. From the preliminary results, it is an interesting finding that data-driven methods such as machine learning are not found among the methods used for basal insulin dose guidance for people with T2D in the existing literature. Such methods are often used to explore different research fields. This elucidates an apparent gap within the field regarding data-driven methods such as machine learning, and to some extent mathematical models. The use of such methods may bring insight to the field, which could potentially pioneer future research.

This apparent lacking use of data-driven methods in the field of basal insulin dose guidance for people with T2D could be a result of the heterogeneity of this population caused by factors such as varying pancreatic insulin production and insulin sensitivity. This complicates the modelling of blood glucose for people with T2D.

Furthermore, limited information about blood glucose levels is usually available for people with T2D since glucometers are most commonly used for measuring blood glucose. In comparison use of continuous glucose monitoring for measuring blood glucose is more widespread in the treatment of people with type 1 diabetes enabling more complex insight into the blood glucose levels. Therefore, the modelling of the effect of insulin on the blood glucose in people with T2D is challenged by the heterogeneity of the population and the limited insight into the effects on blood glucose levels due to the current standard for measuring blood glucose for these individuals. Similar challenges have been recognized by researchers investigating the use of mathematical models in the development of basal insulin dose guidance aimed at people with T2D.

5 CONCLUSION

The present systematic review will inform investigators of methods used to develop basal insulin dose guidance for people with T2D, and categorize the methods used to provide insight into gaps within the field. Preliminary results show the use of paper-based titration algorithms, telehealth solutions, and mathematical models. The use of mathematical models is limited. Furthermore, preliminary results elucidate an apparent gap in the use of data-driven methods such as machine learning for basal insulin dose guidance for people with T2D. Further results will follow.

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