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Editorial

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AI-Based Insulin Dose Optimization: Advancing Precision Glycemic Management Through Intelligent Algorithms

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Introduction

Achieving optimal glycemic control in people with diabetes requires accurate insulin dosing that adapts to daily fluctuations in diet, physical activity, stress, and illness. Traditional insulin dosing methods rely heavily on fixed regimens, patient experience, and intermittent glucose measurements, which often fail to capture the dynamic nature of glucose metabolism. Recent advances in artificial intelligence (AI) have opened new possibilities for insulin dose optimization by enabling data-driven, personalized, and adaptive decision-making. AI-based systems are increasingly being integrated into diabetes care to improve accuracy, reduce hypoglycemia, and enhance overall glycemic outcomes [1,2].

Discussion

AI-based insulin dose optimization uses machine learning algorithms to analyze large volumes of patient-specific data, including continuous glucose monitoring (CGM) readings, insulin delivery history, carbohydrate intake, physical activity, and physiological responses. By identifying complex patterns and trends within these datasets, AI models can predict future glucose levels and recommend optimal insulin doses in real time. Unlike traditional rule-based approaches, AI systems continuously learn and refine their recommendations as new data become available [3,4].

One of the most impactful applications of AI in diabetes care is the development of closed-loop or "artificial pancreas" systems. These systems combine CGM devices, insulin pumps, and AI-driven control algorithms to automate insulin delivery with minimal user input. Clinical studies have shown that such systems improve time-in-range, reduce glycemic variability, and lower the risk of nocturnal hypoglycemia. AI also supports decision-assistance tools that provide personalized dosing recommendations for individuals using multiple daily injections.

Beyond glucose data, advanced AI models incorporate contextual factors such as meal composition, exercise intensity, circadian rhythms, and stress levels. This holistic approach allows for more precise insulin adjustments and better anticipation of glycemic excursions. Additionally, AI-powered platforms can offer educational feedback, helping patients understand the impact of lifestyle choices on insulin needs and encouraging adherence to therapy [5].

Despite its promise, AI-based insulin optimization faces challenges, including data quality, algorithm transparency, cybersecurity concerns, and equitable access to technology. Ensuring clinical validation, regulatory oversight, and user trust is essential for widespread adoption. Moreover, AI systems must be designed to complement, rather than replace, clinical judgment and patient autonomy.

Conclusion

AI-based insulin dose optimization represents a significant advancement in personalized diabetes management. By leveraging intelligent algorithms to deliver adaptive and precise insulin recommendations, these systems have the potential to transform glycemic control and improve quality of life for individuals with diabetes. Continued innovation, rigorous validation, and patient-centered design will be key to fully realizing the benefits of AI-driven insulin therapy.

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