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Dialogue

Endocrinologists in golden age: opportunities enabled by artificial intelligence

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Highlights

- Novel AI technologies enhance endocrinologists' capacity and efficiency in diagnosis, treatment, and follow-up for patient.
- Endocrinologists empowered by AI provide better care for patients with endocrine diseases.

Focused on the theoretical development and practical enhancement of computer systems and algorithms, artificial intelligence (AI) is capable of performing tasks traditionally requiring human intelligence. The endocrine system is a complex biological system involving hormones and metabolites. It is a complicated network of local and systemic interactions between receptors and signaling pathways [1]. The endocrine system is regulated by various factors including genetic, epigenetic, and environmental influences. A deeper understanding of the complexity of the endocrine system always lies beyond the capacities of human brains. AI is particularly suitable to deal with the complexity of the endocrine system and the long-term management of endocrine disorders. With the rapid development of AI technologies, numerous opportunities will be presented to endocrinologists. The accuracy of diagnosis and treatment will be improved, the management of chronic diseases will be optimized, and the scientific research innovation will be inspired in the era of AI [2].

AI frees endocrinologists from routine tasks

Repetitive medical document work is a heavy burden to medical professionals. Endocrine disorders are characterized by chronic and comprehensive medical histories with multiple complications that must be precisely recorded. With the help of speech and image recognition provided by AI, the paperwork will be more efficiently dealt with and one can pay more attention to clinical care. For instance, Nuance Communications has developed a speech recognition software known as "Dragon Medical One" that enables endocrinologists to input medical records directly into electronic health record systems using voice commands, thereby streamlining the documentation process [3]. Moreover, it is known that for patients, endocrine diseases are often accompanied with psychological issues caused by pathophysiological effects, treatment side effects, and psychosocial stressors. Research indicates that the prevalence of depression among individuals with diabetes is two to three times higher than that in the general population, with anxiety disorders affecting up to 40% of these patients [4]. By fully employing AI, endocrinologists can spare more time to deliver compassionate and patient-centered care while leaving the routine tasks to AI. In summary, AI will significantly enhance the work efficiency of endocrinologists.

AI empowers endocrinologists with machine learning

Machine learning (ML) is a critical component of AI that imitates human logic with various algorithms such as interpretable algorithms, pattern mining algorithms, clustering algorithms, and ensemble algorithms. Once trained with some extensive datasets such as personalized patient data, ML can assist endocrinologists in predicting the prognosis or outcomes of a treatment, thereby facilitating early diagnosis and optimizing individualized treatment plans. Type 2 diabetes mellitus (T2DM) is a significant risk factor for coronary heart disease (CHD). In a study conducted by Tang *et al.* [5], the SMOTENC algorithm was applied to a cohort of 12 400 cardiovascular inpatients to investigate theT2DM risk factors and identified history, blood glucose levels, and glycatedhemoglobin (HbA1c) as primary contributors to T2DM in CHD. The results can effectively aid physicians in implementing tailored interventions for high-risk patients. Polycystic ovary syndrome (PCOS) is a term encompassing a complex hormonal and metabolic disorder that predominantly affects women of reproductive age. The diagnosis of PCOS often involves a prolonged process of several months to years since consultations with multiple healthcare professionals are usually necessary due to its heterogeneous nature. Agirsoy *et al.* [6] explored the application of ML algorithms to facilitate a more rapid and precise diagnosis of PCOS. Their study revealed that the extreme gradient boosting (XGBoost) model, which incorporated a diverse array of features—including follicle count on both ovaries, weight gain, anti-Müllerian hormone levels, hair growth, menstrual irregularity, fast food consumption, acne, and hair loss—exhibited robust diagnostic performance.

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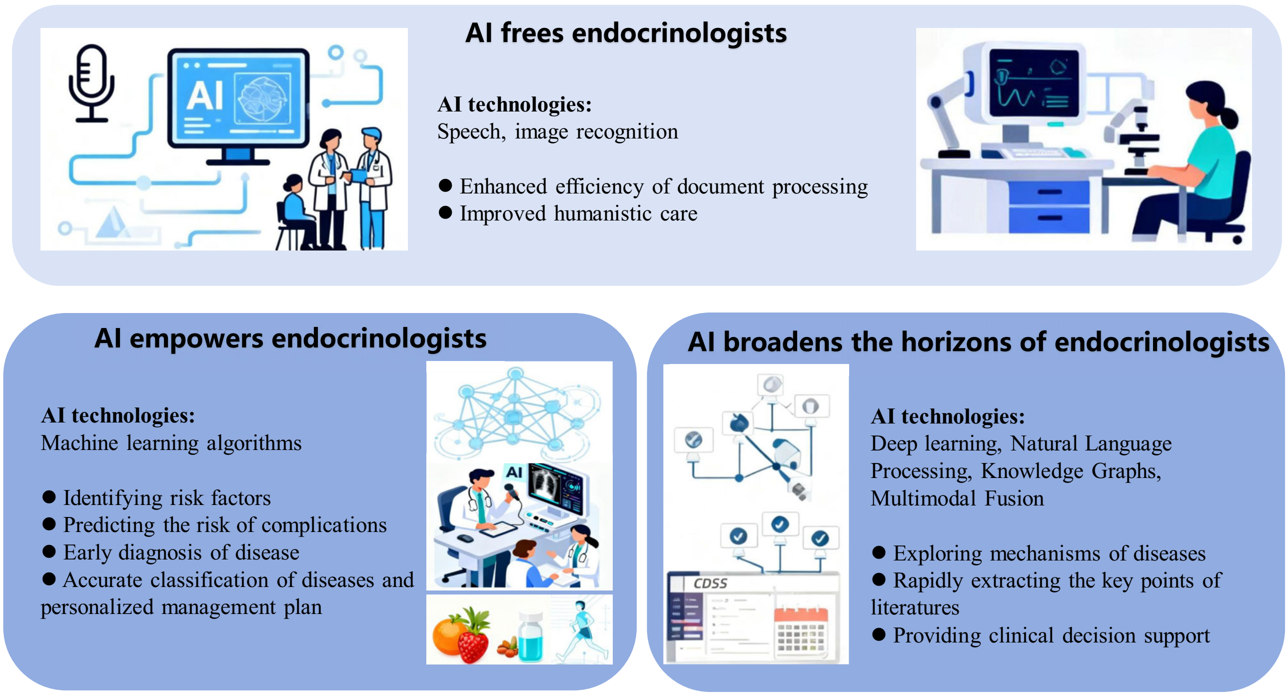

Figure 1. AI inspires numerous opportunities for endocrinologists.

The model presents a reliable and non-invasive alternative to the traditional invasive methods of PCOS assessment. Furthermore, AI has shown significant potential in disease sub-typing. T2DM is a heterogeneous condition involving multiple factors and its development is attributed to the interactions of genetic predisposition and environmental influences. However, conventional classification—such as T1DM, T2DM, monogenic diabetes, and gestational diabetes—are inadequate for the requirements of precision medicine. Meanwhile, individuals with T2DM often exhibit diverse clinical manifestations and varying responses to treatment. Endocrinologists can effectively analyze the complex characteristics of diabetic patients by virtue of AI, enabling precise disease sub-typing and tailored therapeutic interventions. In 2018, Ahlqvist *et al.* employed two-step cluster analysis and k-means clustering on a cohort of 8 980 newly diagnosed diabetic patients in Sweden. A group of six clinical indicators including age at onset, body mass index, HbA1c, β-cell function, insulin resistance, and glutamic acid decarboxylase antibodies were utilized. The study identified five distinct clusters with varying risks of complications. For example, cluster 2, characterized by impaired β-cell function, exhibited an elevated risk of diabetic retinopathy, whereas cluster 3, defined by severe insulin resistance, was more susceptible to chronic kidney disease [7]. Subsequently, Linong Ji's team validated this classification in Chinese patients, thereby improving the formation of individualized treatment strategies and promoting the precision of complication prediction [8]. In summary, endocrinologists are capable of making more forward-looking and precise clinical decisions with the help of AI.

AI broadens the horizon of endocrinologists

With the progress in key technologies such as deep learning and natural language processing (NLP), AI has progressed from performing "simple computations" to being capable of "understanding why" in a more sophisticated manner. Such evolutions enable AI's competence in the exploration of disease mechanisms, multidimensional data fusion, and decision support. In a study conducted by Zhang *et al.* [9], various bioinformatics algorithms, including weighted gene co-expression network analysis (WGCNA), least absolute shrinkage and selection operator (LASSO), support vector machine recursive feature elimination (SVM-RFE), and recursive feature elimination (RFE), were employed to examine the role of metabolism-related genes in the pathogenesis of diabetic nephropathy (DN). The study identified ADI1, PTGS2, DGKH, and POLR2B as diagnostic biomarkers of DN and elucidated their association with the immune infiltration landscape, thereby offering a novel perspective for future research and clinical management of DN. NLP represents a significant technological advancement that merges computational linguistics with statistical modeling, ML, and deep learning, thereby enabling computers to recognize, understand, and generate text and speech. Accordingly, endocrinologists can apply NLP to keep up with the latest scientific research progress. Furthermore, supported by the large language models and advanced data-mining capabilities, AI can integrate the extensive knowledge bases with the practical data to offer evidence-based support for decision-making. A clinical decision support system is a computer-based system designed to aid physicians in decision-making. It covers various AI technologies including knowledge graphs, NLP, deep learning, and multimodal fusion. It can provide endocrinologists with accurate diagnostic and treatment recommendations. For instance, endocrinologists can query the system with questions like "What should be the first-line treatment options for a newly diagnosed T2DM patient who is obese and has mild renal impairment?". The system will then promptly integrate the most recent domestic and international guidelines, pharmaceutical instructions, and substantial evidence-based literature to form a personalized treatment recommendation [10]. In summary, AI has the potential to accelerate scientific advancement and provide decision support for endocrinologists.

The emergence of AI has inspired numerous opportunities for endocrinologists in disease screening, diagnosis, and treatment and in exploring the complex mechanisms of endocrine disorders (Fig. 1). The introduction of AI to endocrinology is creating a promising future where endocrinologists and AI work as a team to provide a better outcome for the patient. In conclusion, AI should never be regarded as a competitor intended to replace us, but rather as a powerful tool that frees us from routine tasks, supports us in decision making, and assists us in scientific exploration.

Author contributions

Bing Li (Formal analysis, Project administration, Resources, Writing—original draft), Qingzheng Wu (Data curation, Software), and Zhaohui Lyu (Conceptualization, Supervision).

Conflict of interest

The authors declare no competing interests.

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