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SHORT COMMUNICATION

Trends in the use of artificial intelligence in the treatment of diabetic foot

Tendencias en el uso de la inteligencia artificial en el abordaje del pie diabético

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ABSTRACT

Introduction: Diabetes mellitus is a chronic disease with high incidence and prevalence worldwide, whose complications negatively affect the patient's quality of life. The incorporation of artificial intelligence in diabetic foot care shows potential for early detection and better decision-making.
Objective: to describe trends in the use of artificial intelligence in the management of diabetic foot.
Method: a search for information was conducted in the Scopus and SciELO databases. A search strategy using keywords and Boolean operators was employed.
Development: artificial intelligence is revolutionizing healthcare through early detection and prevention of ulcers. Through predictive models, image analysis, and remote monitoring, it personalizes treatments and standardizes evaluations, resulting in more effective and cost-effective interventions for the system.
Conclusions: artificial intelligence is a valuable tool in the management of diabetic foot, initiating a paradigm shift from an ulcer-centered model to a comprehensive, proactive, and predictive approach. This change is based on key advances: the enhancement and objectification of clinical diagnosis, the capacity for continuous, real-time monitoring, the anticipation of serious complications, and the democratization of care and patient empowerment.

Keywords: Diabetic Foot Ulcer; Diabetes Mellitus; Artificial Intelligence; Machine Learning.

RESUMEN

Introducción: la diabetes mellitus constituye una enfermedad crónica con alta incidencia y prevalencia a nivel mundial, cuyas complicaciones influyen negativamente en la calidad de vida del paciente. La incorporación de la inteligencia artificial en la atención al pie diabético muestra potencialidades para la detección temprana y mejor toma de decisiones.
Objetivo: describir las tendencias en el uso de la inteligencia artificial en el manejo del pie diabético.
Método: se realizó una búsqueda de información en las bases de datos Scopus y SciELO. Se empleó una estrategia de búsqueda mediante el uso de palabras clave y operadores booleanos.
Desarrollo: la inteligencia artificial revoluciona el cuidado de la salud mediante la detección precoz y prevención de úlceras. A través de modelos predictivos, análisis de imágenes y monitoreo remoto, personaliza tratamientos, estandariza evaluaciones, resultando en intervenciones más eficaces y costo-efectivas para el sistema.
Conclusiones: la inteligencia artificial es una herramienta de gran valor en el abordaje del pie diabético, iniciando un cambio de paradigma, transitando de un modelo centrado en la úlcera, a un enfoque integral, proactivo y predictivo. Este cambio se fundamenta en avances clave: la potenciación y objetivación del diagnóstico clínico, la capacidad de monitorización continua y en tiempo real, la anticipación de complicaciones grave y la democratización del cuidado y empoderamiento del paciente.

Palabras clave: Úlcera del Pie Diabético; Diabetes Mellitus; Inteligencia Artificial; Machine Learning.

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INTRODUCTION

Diabetes has become a global epidemic, with an upward trend in recent decades, affecting millions of people of all ages, with a greater impact in low- and middle-income countries. It is a chronic metabolic disease characterized by high blood glucose levels, which causes cardiovascular, arterial, renal, ocular, and nervous system damage. According to data from the World Health Organization, nearly 830 million people worldwide live with diabetes, more than half of whom do not receive treatment.[1]

There are many risk factors for developing the disease, including genetic, behavioral, and dietary factors, as well as the coexistence of other diseases, such as high blood pressure.

Diabetic foot (DF) can be defined as a wound that penetrates the skin in any region below the ankle in people with diabetes and also includes gangrene and necrosis as a result of the interaction of different factors induced by sustained hyperglycemia and previous traumatic causes, even if the foot does not present any lesions.[2]

These conditions represent one of the main causes of disability, loss of quality of life, and hospitalization in patients with DF. Therefore, risk stratification for the development of diabetic foot conditions (such as ulcers), early and timely diagnosis, and subsequent treatment are of great importance.

Artificial intelligence is now established as a highly valuable tool. Its use has spread to different areas, such as education,[3] social sciences,[4] business,[5] and biomedicine. Its uses have been analyzed in many areas, such as cardiology[6] for the early detection of heart attacks, and ophthalmology[7] for the detection of diabetic retinopathy.

The present study aims to describe trends in the use of artificial intelligence in the management of diabetic foot.

METHOD

A search for information was conducted in Scopus and SciELO on the use of artificial intelligence in the management of diabetic foot.

A search strategy was used to obtain the information, combining terms using Boolean operators.

To determine the use of artificial intelligence, the following terms were used: Artificial Intelligence; Deep Learning; Expert System; Fuzzy System; Extreme Gradient Boosting; Random Forest; Convolutional Neural Networks; ChatBot; Support Vector Machine, as well as their translations into English. To identify articles on diabetic foot, the following terms were used: diabetic foot, diabetic foot ulcer, and their translations into English. The Boolean operators OR and AND were used to combine the terms. The search was conducted using the title (TITLE) and abstract (ABSTRACT) fields.

Original articles published between 2022 and 2023, in Spanish and English, were selected. These articles allowed access to the full text and, after analysis of their abstracts and full texts, were found to be in line with the research objective.

DEVELOPMENT

A group of trends were identified in research on the application of artificial intelligence in the management of diabetic foot. These trends are shown below:

Focus on early detection and prevention

The studies revealed a strong trend toward the use of AI for the early identification of risk factors and signs of disease in its early stages, even at stages imperceptible to the human eye. This allows healthcare personnel to proactively plan health actions to prevent the formation of ulcers or other complications.[8,9]

AI as a tool for predicting adverse outcomes

Advances have been made in the development and optimization of AI-mediated predictive models to estimate the probability that an ulcer will not heal properly or that the patient will suffer an amputation. This factor is of great value in personalizing treatments according to the patient's potential needs, as well as in prioritizing those who need more intensive treatments, allowing for efficient use of resources.[10]

Automation and standardization of approaches

AI can be a fundamental support in avoiding bias and variability in wound assessment through image-based recognition techniques, without replacing clinical judgment. Image analysis allows AIs to automatically classify, measure, and analyze ulcers, providing objective and reproducible data that enables healthcare personnel to improve monitoring and treatment.[11,12,13]

Extracting hidden value and enriching data

The application of Natural Language Processing techniques is capable of analyzing large volumes of unstructured medical records to identify the presence of risk factors in patients, which would be extremely complex or impossible to do manually on a large scale.[14] This allows for the establishment of risk stratification in patients and the creation of care plans to prevent the onset of complications.[15,16]

Interpretability of models

A trend toward the development of self-explanatory systems was identified. In other words, it is not enough for an AI model to make a prediction; it is increasingly common to seek models that are capable of "explaining" how and why they have reached their conclusion, which not only allows for the detection of errors or the optimization of algorithms, but also enables them to be used in

human resources training.[17,18,19] In turn, this builds trust among healthcare personnel, enabling them to learn and use these systems.

Continuous and remote monitoring

The use of portable and wearable technologies is becoming increasingly important today. The daily use of these devices, together with mobile applications, is an invaluable resource for continuous patient monitoring and real-time data collection in a non-hospital setting. The analysis of temperatures, plantar pressure, and gait patterns can alert to imminent risks of ulceration.[20,21]

Empowering patients in their self-care

Technology is manufactured to be used by users, which is why the development of mobile applications and their link to AI can promote personalized education and, in turn, offer self-management tools, making patients active participants in their own self-care and prevention of complications.[22,23]

Cost-effective interventions

In addition to the clinical benefits for treatment and rehabilitation, there is growing awareness of the role of prevention in improving quality of life and reducing costs. Research shows that investing in AI-mediated prevention, screening, and diagnostic programs is economically profitable, reducing hospitalization rates and the incidence of costly complications such as amputations.

CONCLUSIONS

The studies analyzed show that artificial intelligence has t as a valuable tool in the treatment of diabetic foot, initiating a paradigm shift from an ulcer-centered model to a comprehensive, proactive, and predictive approach. This change is based on key advances: the enhancement and objectification of clinical diagnosis, the ability to monitor continuously and in real time, the anticipation of serious complications, and the democratization of care and patient empowerment.

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CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTION

Conceptualization: Barbarito Malagón Silva.
Writing – initial draft: Barbarito Malagón Silva.
Writing – review and editing: Barbarito Malagón Silva.

BIBLIOGRAPHICAL REFERENCES

1. World Health Organization. Diabetes. WHO; 2024. https://www.who.int/health-topics/diabetes

2. Bandyk DF. The diabetic foot: Pathophysiology, evaluation, and treatment. Seminars in Vascular Surgery. 2018; 31(2-4):43-8. https://linkinghub.elsevier.com/retrieve/pii/S0895796719300110

3. Pérez GAJ. Benefits and challenges of using AI in heritage education. EthAIca. 2024; 3:102-102. https://ai.ageditor.ar/index.php/ai/article/view/102

4. Hernández-Lugo M de la C. Artificial Intelligence as a tool for analysis in Social Sciences: methods and applications. LatIA. 2024; 2:11-11. https://latia.ageditor.uy/index.php/latia/article/view/11

5. Juárez GE, Gambino N. Professionalization and Artificial Intelligence in Family Businesses. EthAIca. 2024; 3:139-139. https://ai.ageditor.ar/index.php/ai/article/view/139

6. Muthusundari S, Priyadharshii M, Preethi V, Priya K, Priyadharcini K. Smart watch for early heart attack detection and emergency assistance using IoT. LatIA. 2024;2:109-109. https://latia.ageditor.uy/index.php/latia/article/view/109

7. Injante R, Julca M. Detection of diabetic retinopathy using artificial intelligence: an exploratory systematic review. LatIA. 2024; 2:112-112. https://latia.ageditor.uy/index.php/latia/article/view/112

8. Cassidy B, Hoon Yap M, Pappachan JM, Ahmad N, Haycocks S, O'Shea C, et al. Artificial intelligence for automated detection of diabetic foot ulcers: A real-world proof-of-concept clinical evaluation. Diabetes Research and Clinical Practice. 2023; 205:110951. https://www.sciencedirect.com/science/article/pii/S0168822723007143

9. Dhankhar S, Garg N, Chauhan S, Saini M. Role of Artificial Intelligence in Diabetic Wound Screening and

Early Detection. Current Biotechnology. 2024; 13(2):93-106. https://www.benthamdirect.com/content/journals/cbiot/10.2174/0122115501303253240408072559

10. Artificial intelligence of arterial Doppler waveforms to predict major adverse outcomes among patients with diabetes mellitus. Journal of Vascular Surgery. 2024;80(1):251-259.e3. https://www.sciencedirect.com/science/article/pii/S0741521424004014

11. Recognition of ischaemia and infection in diabetic foot ulcers: Dataset and techniques. Computers in Biology and Medicine. 2020; 117:103616. https://www.sciencedirect.com/science/article/pii/S0010482520300160

12. Khandakar A, Chowdhury MEH, Reaz MBI, Ali SHM, Kiranyaz S, Rahman T, et al. A Novel Machine Learning Approach for Severity Classification of Diabetic Foot Complications Using Thermogram Images. Sensors. 2022; 22(11):4249. https://www.mdpi.com/1424-8220/22/11/4249

13. Khandakar A, Chowdhury MEH, Reaz MBI, Ali SHM, Abbas TO, Alam T, et al. Thermal Change Index-Based Diabetic Foot Thermogram Image Classification Using Machine Learning Techniques. Sensors. 2022; 22(5):1793. https://www.mdpi.com/1424-8220/22/5/1793

14. Mining peripheral arterial disease cases from narrative clinical notes using natural language processing. Journal of Vascular Surgery. 2017; 65(6):1753-61. https://www.sciencedirect.com/science/article/pii/S0741521416318444

15. Tulloch J, Zamani R, Akrami M. Machine Learning in the Prevention, Diagnosis and Management of Diabetic Foot Ulcers: A Systematic Review. IEEE Access. 2020; 8:198977-9000. https://ieeexplore.ieee.org/abstract/document/9246496

16. Natural language processing of clinical notes for identification of critical limb ischemia. International Journal of Medical Informatics. 2018; 111:83-9. https://www.sciencedirect.com/science/article/pii/S1386505617304756

17. Xie P, Li Y, Deng B, Du C, Rui S, Deng W, et al. An explainable machine learning model for predicting in-hospital amputation rate of patients with diabetic foot ulcer. International Wound Journal. 2022;19(4):910-8. https://onlinelibrary.wiley.com/doi/abs/10.1111/iwj.13691

18. Identifying patterns in multiple biomarkers to diagnose diabetic foot using an explainable genetic programming-based approach. Future Generation Computer Systems. 2023; 140:138-50. https://www.sciencedirect.com/science/article/abs/pii/S0167739X2200334X

19. Toofanee MSA, Dowlut S, Hamroun M, Tamine K, Petit V, Duong AK, et al. DFU-SIAM a Novel Diabetic Foot Ulcer Classification With Deep Learning. IEEE Access. 2023; 11:98315-32. https://ieeexplore.ieee.org/abstract/document/10242064

20. Kaselimi M, Protopapadakis E, Doulamis A, Doulamis N. A review of non-invasive sensors and artificial intelligence models for diabetic foot monitoring. Front Physiol. 2022;13. https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2022.924546/full

21. Chemello G, Salvatori B, Morettini M, Tura A. Artificial Intelligence Methodologies Applied to Technologies for Screening, Diagnosis and Care of the Diabetic Foot: A Narrative Review. Biosensors. 2022;12(11):985. https://www.mdpi.com/2079-6374/12/11/985

22. Pappachan JM, Cassidy B, Fernandez CJ, Chandrabalan V, Yap MH. The role of artificial intelligence technology in the care of diabetic foot ulcers: the past, the present, and the future. World J Diabetes. 2022;13(12):1131-9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9791570/

23. Chan KS, Chan YM, Tan AHM, Liang S, Cho YT, Hong Q, et al. Clinical validation of an artificial intelligence-enabled wound imaging mobile application in diabetic foot ulcers. International Wound Journal. 2022; 19(1):114-24. https://onlinelibrary.wiley.com/doi/abs/10.1111/iwj.13603