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Review article

Implementing artificial intelligence and deep learning in medical consultations

Implementación de la inteligencia artificial y el aprendizaje profundo en las consultas médicas

Implementação de inteligência artificial e aprendizagem profunda em práticas médicas

Jorge Luis Saavedra Rubio
Universidad Carlos III de Madrid, Madrid, España / jlsaavedra89r@gmail.com
https://orcid.org/0000-0001-5937-1840

Kenia C. Sánchez Espinosa
Universidad de Vigo, Ourense, España / ksanchez8909@gmail.com
https://orcid.org/0000-0003-3657-9440

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Abstract

Artificial intelligence and deep learning are valuable computer tools for the healthcare sector. The objective of this review was to demonstrate worldwide experiences with their implementation in medical consultations. A PubMed literature search was conducted, analyzing publications from the last five years. These algorithms allowed for the preparation of medical records, treatment recommendations, assessment of teleconsultation quality, and the use of virtual assistants; thereby, expanding access to healthcare and reducing exposure to diseases in healthcare centers. It is

concluded that artificial intelligence and deep learning represent a viable resource for consultation, especially in the face of natural disasters and in hard-to-reach areas. Therefore, the necessary IT infrastructure must be created for their healthcare application.

Keywords: neural learning, telemedicine, health services management.

Resumen

La inteligencia artificial y el aprendizaje profundo constituyen herramientas informáticas útiles para el sector de la salud. El objetivo de esta revisión fue demostrar las experiencias que se tienen a nivel mundial con su implementación en las consultas médicas. La búsqueda documental se realizó en PubMed, y se analizaron las publicaciones realizadas en los últimos cinco años. Estos algoritmos permitieron preparar historiales clínicos, indicar tratamientos, evaluar la calidad de teleconsultas y utilizar asistentes virtuales; lo cual contribuyó a ampliar el acceso a la atención médica y reducir la exposición a enfermedades en los centros de salud. Se concluye que, la inteligencia artificial y el aprendizaje profundo constituyen una vía viable de consulta, sobre todo ante desastres naturales y en zonas de difícil acceso; por lo que debe crearse la infraestructura informática necesaria para su aplicación en el sector sanitario.

Palabras claves: aprendizaje neuronal, telemedicina, gestión de servicios de salud.

Resumo

A inteligência artificial e o aprendizado profundo são ferramentas de computação úteis para o setor de saúde. O objetivo desta revisão foi demonstrar as experiências mundiais com sua implementação em consultas médicas. A busca documental foi realizada no PubMed, e foram analisadas as publicações realizadas nos últimos cinco anos. Esses algoritmos permitiram elaborar histórias clínicas, indicar tratamentos, avaliar a qualidade das teleconsultas e utilizar assistentes virtuais; o que contribuiu para ampliar o acesso à assistência médica e reduzir a exposição a doenças nos centros de saúde. Conclui-se que a inteligência artificial e o aprendizado profundo constituem uma

forma viável de consulta, principalmente diante de desastres naturais e em áreas de difícil acesso; Portanto, a infraestrutura de TI necessária deve ser criada para sua aplicação no setor de saúde.

Palavras-chave: aprendizagem neural, telemedicina, gestão de serviços de saúde.

Introduction

The term artificial intelligence (AI) was first introduced in the 1950s and refers to the ability of computer systems to think and act like humans in comparable situations, and to predict the outcomes of these responses (El-Sherif *et al*., 2022). Since the 1970s, there has been evidence of its use in medicine. Early experiences focused on medical diagnostics, interpreting data from chemical studies, and developing computer models of human behavioral processes (Jiménez, 2021).

In the 1980s, *deep learning*, arouse as a promising type of neural learning, evolving from artificial neural networks. It represents a specific case of *machine learning*, which, in turn, is an application of AI (Faris *et al.*, 2022). This technique has had a significant impact on advanced image analysis, drug discovery, disease prediction, and the acceleration of knowledge through genomic sequencing (Kaul *et al.*, 2020).

Currently, AI and deep learning have been propelled in the healthcare sector by the generation and collection of massive amounts of data that cannot be manipulated, analyzed, and processed using traditional mechanisms (Habib *et al.*, 2021). Both technologies contribute to the development of various forms of virtual healthcare modalities, which are rapidly growing in the healthcare delivery process. It is estimated that there will be a 15% annual growth in this field, and the market is projected to reach up to $135 billion by 2025 (Rutledge *et al.*, 2020).

Among these modalities, there are services such as AI and deep learning-assisted medical consultations, which use information and communication technologies to transfer medical information for the provision of clinical and educational services. These services help overcome the challenges of healthcare delivery related to time, distance, and access to geographically complex areas (Kuziemsky *et al.*, 2019).

This review work demonstrates some international experiences on this topic. The literature review was conducted through PubMed using the keywords *"artificial intelligence", "deep learning,"* and *"medical consultations"*. Publications from the last five years written in Spanish or English and available in full-text, specifically addressing the application of these technologies in medical consultations, were selected for reading. Additionally, other relevant experiences found on Google Scholar were included.

Development

In 1975, Harry Popple and Jack Myers, both from the University of Pittsburgh, first introduced AI into a computerized general medical consultation system called DIALOG. This system incorporated a hypothesis-generating system using a medical knowledge base with diagnostic behavior and proficiency comparable to those of an expert physician (Jiménez *et al.*, 2021).

During the 1970s to 1980s, other programs such as MYCIN, EMYCIN, and INTERNIST-1 were developed. These programs recommended antibiotic treatment options to physicians, appropriately adjusted based on the patient's body weight (Kaul *et al.*, 2020). Later, a decision support system known as DXplain was developed by the University of Massachusetts in 1986, providing a list of probable diagnoses based on symptoms (Amisha *et al.*, 2019).

Over time, algorithms have been improved. Currently, medical consultations can use AI to automatically generate risk assessments and highlight the most important actions based on a patient's medical history. In addition, the recorded dialogue from the consultation can be converted into a summary letter that the physician can approve or modify (Buch *et al.*, 2018).

In addition, these AI systems can remind physicians to provide explanations that are less obvious but require consideration or exclusion, improving their performance (Rutledge et al., 2020). This helps reduce medical errors due to problems in the doctor-patient relationship, inadequate clinical examination, or poor evaluation of data and test results (Lobo, 2018).

At present, in collaboration with Stanford University, Google is developing a project called *Medical Digital Assist*, which aims to take advantage of the power of AI to take notes during

medical examinations. The project aims to select and document the crucial parts of the conversation. The main focus of this technology[1] is to make patient records more accessible, save time, and improve accuracy.

IBM for its part, has a similar project called Watson[2], which not only collects patient data but also compares it to a huge database that includes treatment guidelines and a comprehensive listing of similar diagnoses. Similarly, Savana.com[3] has developed a scientific method that uses AI to unlock the clinical value of free-text electronic health records and put them in the hands of healthcare professionals to improve medical knowledge worldwide.

Medical consultations conducted via synchronous video, audio, or chat connections with mobile devices or web browsers enable medical examinations, diagnoses, and treatment recommendations for a wide range of not life-threatening-conditions (Rutledge *et al.,* 2020). One of the challenges with this modality is assessing call quality, which often depends on human auditing. However, with the daily increase in consultations, this is becoming an impractical and inefficient method. (Chuo *et al.*, 2020).

Therefore, through deep learning, Habib *et al.* (2021) automated the process of assessing the quality of conversations based on patient and physician voices on the digital health platform Altibbi[4], which provides telemedicine and telehealth services in the Middle East and North Africa. The models they proposed (a signal-based model, a transcription-based model, and a hybrid model) achieved promising results and improved the accuracy of the traditional approach followed by Altibbi's operations team.

Another inconvenience of these online medical calls is the loss of the telecommunication link or the unavailability of the remote physician. AI could remedy this through various mechanisms by enabling human or virtual interactions and addressing the difficulties related to the scheduling and availability of the physician.

[1] Google Brain: Medical Digital Assist. Available at www.huskyintelligence.com
[2] Watson IBM. Available at www.ibm.com/watssor
[3] AI and Medical Diagnosis: A Compact Guide. Available at www.savanamed.com
[4] Available at www.altibbi.com

The solution to these issues has a positive impact on the use of online medical consultations on a more regular basis. At the same time, they provide an alternative to reduce patient absenteeism from outpatient visits, which has a global prevalence of around 25% and leads to economic losses and increased patient waiting times. Salazar et al. (2020) reported that unjustified absence from scheduled medical appointments resulted in an impact of at least 3.8 million euros in 2016 for 20 units under the responsibility of the state government of Brazil.

However, according to the National Quality Forum in Washington, D.C., the use of these telemedicine services should be assessed considering access to care, cost-benefit ratio, medical team and community experience, and clinical, operational, and technical effectiveness (Elhence *et al.*, 2022). On the other hand, Kuziemsky *et al.* (2019) suggest that key social and ethical considerations for enabling AI-enabled telemedicine or its modalities include ensuring equitable access to services, monitoring the technology gap, recognizing that AI is only a tool, and keeping people first.

On the other hand, there are health apps that use virtual assistants to provide a useful complement or alternative to traditional health care models. In 2014, the Babylon Health[5] application was launched to provide AI medical consultations based on personal medical history and general medical knowledge. This includes a *chatbot* for checking symptoms, which is also based on AI and allows users to obtain relevant medical information at any time after answering a few questions. In this way, the AI system estimates health status depending on the answers and symptoms recorded.

Another example of integrating AI into this virtual health model is the HealthTap[6] platform, which provides users with instant access to primary care. The platform enables a comprehensive health experience and captures the necessary data to enable continuous improvement in its performance. The content library contains 1.7 million questions, 2.5 million answers, and 2.7 million peer reviews of those answers by medical professionals.

[5] Available at www.babylonhealth.com
[6] Available at www.healthtap.com

The user can resubmit the inquiry if the library's response is unsuitable, and one of the network's physicians will respond, usually within a few hours or minutes. The option to first consult with the symptom assessment tool, which performs a medical interview through a *chatbot* and provides a report classified by a variety of potential conditions, is available to users who wish to be examined by a doctor. This information is provided to the user to help them understand the problems, the causes of the symptoms, and the need of getting examined for each one (Rutledge *et al.*, 2020).

In 2019, Japan's Saitama Prefecture launched an emergency consultation service that also uses AI. The service is operated by entering text or phrases on the screen in a chat-like format on a smartphone or personal computer. The AI recognizes the meaning of the text, identifies errors in spelling and context, and displays some possible symptoms. After selecting a symptom, the system displays five levels of urgency by answering questions in a flowchart (Amagasa *et al.*, 2022).

These *chatbots* face the challenge of incorporating, in the future, aspects of affective behavior, using multimodal contextual awareness mechanisms to enable authentic conversational dialogue, and gradually improve their performance as they are currently limited by the assumption of conditional independence of identified features (Kuziemsky *et al.*, 2019). To address this limitation, upcoming versions of the clinical prediction model will be based on deep learning, using data trained with observed clinical data. Each new case entered into the digital health platform is added to the training dataset.

Deep learning methods are capable of extracting implicit and hidden relationships and automatically generating dense feature representations. This capability has already been used for the automatic classification of questions in the Altibbi digital health platform. Faris *et al.* (2022) were the developers of this algorithm, which automatically labels questions and classifies them into 15 categories of medical specialties with a high accuracy rate.

The COVID-19 pandemic exposed significant weaknesses in healthcare systems in many countries, including those in Latin America and the Caribbean (De Cecco & Van Assen, 2022). The use of AI methods and deep learning in various modalities of medical consultations during this period had a significant impact on the healthcare system and emphasized the importance of their

implementation. They allowed for expanded access to medical care, reduced exposure to diseases for both healthcare personnel and patients, preserved scarce supplies of personal protective equipment, and reduced patient demand at healthcare facilities (El-Sherif *et al.*, 2022).

It is a gateway to illustrate future healthcare delivery and has enabled the transition to consumer-centered care paradigms. Similarly, it plays a special role in emergencies such as earthquakes and floods, as well as in remote and hard-to-reach rural areas, by enabling people to access the care they need with appropriate urgency (Buch *et al.*, 2018).

Moreover, increased life expectancy and the growing incidence of chronic diseases have raised the demand and complexity of healthcare, requiring longer interactions between patients and healthcare professionals, which can be shortened with the use of these technologies (Kuziemsky *et al.*, 2019).

Final Considerations

AI and deep-learning tools have changed the way physician-patient interactions occur; they reduce clinical errors and costs in care; foster greater productivity; improve the work environment; and provide support for the self-management of healthcare.

However, the focus of these tools should be on empowering patients and supporting health professionals rather than replacing them. This means changing how physicians are trained and moving toward intensive use of these technologies. Future applications of AI and deep learning in medical consultation must include practices that ensure the integrity, confidentiality, and availability of system information, as well as equitable access.

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Authors' contributions

CRT

Conceptualization: K.C.S.E. and J.L.S.R.; Methodology: K.C.S.E.; Formal analysis: K.C.S.E. and J.L.S.R.; Research: K.C.S.E. and J. L.S.S.R.; Data curation: J.L.S.R.; Drafting (original draft): J.L.S.R.; Drafting (proofreading and editing): K.C.S.E. and J.L.S.R.

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The authors declare that they have no conflict of interest.

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Editing and Layout: Dr. C. Amado Batista Mainegra. Bachelor's degree in Microbiology, Master's degree in Higher Education Sciences, Doctorate in Education Sciences. Coordinator of the Publications Unit at the Instituto Especializado de Profesionales de la Salud, El Salvador. https://orcid.org/0000-0002-0130-2874

Orthotypographic and Stylistic Editing: MSc. Caridad Dailyn López Cruz. Bachelor of Arts (Hispanic Philology), MSc. in Management (Specialization: Management). Advisor to the Directorate of University Extension of the Ministry of Higher Education of Cuba.
https://orcid.org/0000-0001-8810-1129

English translation: Lic. Claudia Ramírez. Translator and Interpreter, Registered Member No. 2142, International Association of Professional Translators and Interpreters.
https://www.iapti.org/member/claudia-ramirez/

Portuguese translation: Dr. Fidel Armando Cañas Chávez. B.A. in Social Communication, M.A. in Applied Linguistics, Ph.D. in Linguistics. Professor of the Department of Foreign Languages and Translation at the University of Brasilia, Brazil.
http://lattes.cnpq.br/1406833402007752