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REVIEW ARTICLE

The use of artificial intelligence in endocrinology

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ABSTRACT

Introduction: Artificial Intelligence (AI) has revolutionized the field of medicine, with the potential to transform the approach to diagnosis and treatment and improve patient outcomes. In recent years, the use of AI in endocrinology has increased.

Objective: This review article summarizes the current status of AI in endocrinology, its potential benefits, and new approaches and advancements in the management of diabetes and thyroid, pituitary, and adrenal diseases. Despite its potential benefits, AI in healthcare faces challenges, including data quality and privacy concerns.

Materials & Methods: PubMed and Google search engines were used for the literature review using the keywords endocrinology, machine learning, artificial intelligence, diabetes mellitus, and thyroid gland disorders. Cross-referencing important articles yielded additional references.

Results: Almost all the retrieved articles were within the last 5-10 years. Review of articles showed the increasing understanding and use of Artificial Intelligence in many fields including medicine and Endocrinology. Machine Learning has become increasingly sophisticated and applicable in the medical workplace to the extent of being used as a confirmatory tool for diagnosis, differential diagnosis, treatment, prognosis, and research.

Conclusion: Despite the promising potential of AI to predict the possibility of acquiring specific diseases, customize treatment plans, and aid in surgical procedures, it is to be remembered that AI in healthcare is still in its infancy, and a lot of work and development is needed to overcome the challenges and limitations associated with its implications in healthcare.

Keywords: Artificial intelligence; Machine Learning; Healthcare; Diagnostics; Therapy; Prognostics.

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INTRODUCTION

The idea of computers replicating intelligent behavior and critical thinking akin to humans was first introduced by Alan Turing in 1950.[1] John McCarthy, a computer scientist, coined the phrase "artificial intelligence" for the first time in 1956 and defined it as the science and engineering of creating intelligent computers.[2,3] The application of artificial intelligence to medicine has been a subject of study for many years., with early work dating back to the 1970s.[2] Overall, the history of AI in medicine is a long and evolving one, with ongoing research and development in the field to explore new ways that AI can be used to improve patient outcome and advance medical research.

The use of AI in medicine has become increasingly popular as technology advances. AI algorithms can be used to diagnose diseases by analyzing medical images and other diagnostic data, provide personalized medical recommendations and therapy plans, and even help doctors make better decisions reducing diagnostic errors and improving patient outcomes.[2]

AI can also be used to discover new drugs by using machine learning algorithms to analyze large amounts of data from previous drug trials, which can help identify potential new drug targets and predict the effectiveness of new drug candidates.[4]

In the field of medical imaging, artificial intelligence (AI) algorithms are being used to examine X-rays, CT scans, and MRI scans in order to find anomalies that may not be immediately evident to the human eye.[2]

Clinical trials are being designed more efficiently and effectively using AI algorithms by predicting patient outcomes and optimizing trial protocols. Overall, AI has the potential to revolutionize the field of medicine by improving patient outcomes, reducing healthcare costs, and increasing operational efficiency.

Endocrinology is a branch of medicine that deals with the study of hormones and the endocrine system. AI can be used in various endocrinological areas to assist with the diagnosis, treatment, and management of endocrine disorders.

This review outlines the current state of artificial intelligence in endocrinology and goes over its possible advantages and drawbacks.

Use of AI in endocrinology

In recent years, the use of artificial intelligence in the field of endocrinology has increased as a result of its potential to enhance patient outcomes and fundamentally alter how patients are diagnosed and treated.

Broadly speaking, AI in medicine has two main components: physical and virtual. The physical component refers to the use of physical devices such as robots and sensors to perform medical procedures and interventions. The virtual component refers to the use of software and algorithms to analyze data and make predictions or diagnosis.[3] In endocrinology both the physical and virtual components of AI can be applied.[6]

Diabetes management

The International Diabetes Federation estimates that 463 million persons worldwide have diabetes in 2019, and that figure is anticipated to reach 700 million by the year 2045.[7] AI is increasingly being used in diabetes management to improve patient outcomes and reduce healthcare costs.

AI can be used to predict the likelihood of a patient developing diabetes or other health-related conditions by analyzing large amounts of data from patient health records. One example of how AI is used in predictive analytics is the DeepHeart study by cardiogram. In this study, a deep neural network (semi-supervised, multi-task Long Short-Term Memory network) was utilized to accurately identify a number of medical problems, including high blood pressure, diabetes, high cholesterol, and sleep apnea.[8]

Self-monitoring of blood glucose (SMBG) is crucial for the proper management of diabetic patients, particularly those with type 1 diabetes who need more intensive insulin therapy.[9] However, SMBG devices only represent snapshot of the actual glycemic status, painful and time consuming, eventually leading to poor compliance.[10] Continuous glucose monitoring (CGM) system measures the concentration of blood glucose continuously in the interstitial fluid via a sensor, the data are then transferred through a transmitter to a receiver / smartphone that shows the results.[11] Dexcom G5, Dexcom G6, FreeStyle Libre and FreeStyle Libre 2 are CGM devices that are replacing fingerstick testing for diabetes treatment decisions.[12]

The DreaMed Advisor Pro system uses machine learning to analyze data from continuous glucose monitoring devices and insulin pumps to provide personalized insulin dosing recommendations for patients with type 1 diabetes mellites. The system was able to enhance glycemic control and lessen the risk of hypoglycemia, according to a clinical trial.[13]

An Artificial Pancreas is a closed-loop control system designed to mimic the human pancreas in patients with type 1 diabetes. It measures blood glucose by CGM and uses sophisticated algorithms to automatically regulate insulin delivery via an insulin pump in response to changes in the patient's blood sugar levels.[14] Patients with type 1 diabetes have to manually manage their blood sugar levels through frequent blood sugar testing and insulin injections. Artificial Pancreas has the potential to greatly improve diabetes management, providing patients with more freedom and better quality of life. However, it is worth noting that this technology is still relatively new and not yet widely available, and it requires ongoing monitoring and maintenance by healthcare professionals.

About one-third of diabetics have diabetic retinopathy (DR), which is a major cause of adult blindness.[15] Early detection and treatment of DR are critical for preserving vision, and AI has emerged as a promising tool for this purpose. AI algorithms can analyze retinal images to detect signs of DR such as microaneurysms, hemorrhages, and exudates. Machine learning techniques, including deep learning, have shown high accuracy in detecting DR from retinal images, sometimes outperforming human ophthalmologists.[16] The IDx-DR system, developed by IDx technologies, received FDA approval in 2018 for autonomous diagnosis of DR and has 87% sensitivity and 97% specificity.[17]

Thyroid disease management

The thyroid gland plays a crucial role in regulating metabolism, and disorders of the thyroid can have a significant impact on a patient's health. The diagnosis of thyroid diseases can be challenging because the symptoms can be non-specific and overlap with other conditions. The gold standard for diagnosis is a combination of physical examination, blood tests, and imaging studies such as ultrasound or biopsy.

In the general population, thyroid nodules are frequent, and the majority of them are benign. However, a small percentage of nodules can be malignant, which makes accurate diagnosis of thyroid nodules important. There is ample literature describing the use of artificial intelligence (AI) techniques to assess thyroid nodules by analyzing medical images, such as ultrasound and MRI scans, and the performance of AI tools has been reported to either match or exceed that of radiologists. Yu Xue, et al., conducted a study which showed that AI-assisted diagnostic technique using ultrasound images had better diagnostic accuracy in differentiating benign vs malignant thyroid nodules with sensitivity and specificity of 0.88 and 0.81 respectively.[18] Apart from medical imaging AI technique can be integrated with other modalities to accurately diagnose thyroid nodules. For example, Sun et al., conducted a study which shows that by integrating high-throughput proteomics and AI technology we can precisely differentiate thyroid nodules which is otherwise difficult to achieve by other methods.[19]

Hyperthyroidism is a common health concern worldwide. Early detection can be challenging because of its vague clinical presentation. A deep-learning algorithm was used by Choi et al., to generate an electrocardiographic biomarker for the early diagnosis of hyperthyroidism.[20] In a second study, Hanai K et al., used a deep neural network to diagnose patients with Graves' ophthalmopathy who had enlarged extraocular muscles using orbital CT images, with 92.5% sensitivity and 88.6% specificity.[21] Moon JH et al., developed a machine learning-assisted system to evaluate active thyroid-associated orbitopathy by analyzing 5 components of clinical activity score (inflammation of the caruncle and / or plica, swelling of the eyes, redness of the eyelids and conjunctiva, and conjunctival edema)

in facial images of patients with sensitivity and specificity of 88.1% and 86.9% respectively.[22]

Pituitary and adrenal disease management

The pituitary and adrenal glands are responsible for the secretion of several hormones that regulate important functions in the human body. Cushing's syndrome is an endocrine condition brought on by long-term exposure to excessive cortisol levels. A random forest-based machine learning algorithm can accurately diagnose and classify Cushing's syndrome subtypes, thus improving physicians' judgment using only a few biochemical tests, which are difficult and upsetting for patients.[23] In order to classify numerous different types of neuroendocrine tumors, including paragangliomas, pheochromocytomas, adrenal carcinomas, adenomas, and hyperplasia, Yang et al., created an intelligent decision system employing a machine learning technique to examine gene expression data of tumor tissue.[24] Primary Aldosteronism (PA) has two subtypes: unilateral PA and bilateral PA. The gold standard diagnostic test for PA is adrenal venous sampling (AVS) which is invasive and has limitations. Shi et al., developed a machine learning-based predictive model to sub classify PA using ten parameters without CT scan; this might reduce the need of AVS and CT scan in future.[25]

Liu et al., developed a machine learning model and rating system based on CT to differentiate between adrenal pheochromocytoma and Lipid-poor adenoma. This model could aid in the identification and individualized care of patients with adrenal tumours.[26]

Challenges and Limitations

Artificial intelligence (AI) has revolutionized the field of medicine. Continued research and development could lead to better diagnosis and management of patients. However, there are certain limitations that need to be addressed. The data used to feed the AI algorithms can be biased and incomplete that can lead to inaccurate and discriminatory results.[27] "Black box" refers to AI systems or models that produce a certain result output through complex internal algorithms and networking that is opaque and not easily understandable to humans. This lack of transparency can be difficult for physicians, who need to know the grounds behind AI-generated diagnoses and recommendations.[28] Accountability is another main concern in the application of AI in medicine. In healthcare, physicians are responsible for the treatment and management of patients. The AI application makes it a concern as to who should be held responsible if the system goes wrong.[28] There are also ethical challenges surrounding the implications of AI in healthcare, particularly regarding patients' data privacy and consent. AI algorithms require a large amount of data to make predictions and diagnose medical conditions. The issue of patient consent is essential in addressing data privacy concerns, particularly when healthcare organizations allow the widespread utilization of patient data for AI training without obtaining adequate individual patient consent.[27]

CONCLUSION

AI has the potential to revolutionize the endocrinology field by improving patient outcomes, reducing healthcare costs, and increasing operational efficiency. AI has already been applied in areas such as diabetes management, thyroid disease management, and reproductive endocrinology. AI can help predict the likelihood of developing certain diseases, personalize treatment plans, and even assist with surgical procedures. However, it is worth noting that while AI can be a valuable tool in endocrinology, it should not replace the clinical judgment and expertise of healthcare professionals. Ongoing research and development in the field of AI will continue to refine its application in endocrinology and improve patient care.

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