Pharma Vision : Research and Reviews

Journal home page : https://sites.google.com/a/ves.ac.in/pharmavision/

ROLE OF ARTIFICIAL INTELLIGENCE IN DIABETES

CORRESPONDING AUTHOR: Mr. Keyur V Shastri (Assistant Professor),

Department of Pharmacognosy, Vivekanand Education Society's College of Pharmacy, Chembur (E), Mumbai-400074

Mobile: 9322378504 E-mail: keyur.shastri@ves.ac.in

AUTHOR

Keyur V Shastri (Assistant Professor),

Department of Pharmacognosy, Vivekanand Education Society's College of Pharmacy, Chembur (E), Mumbai-400074

Ms. Shambhavi A Ghadi,

Second Year M. Pharm (Quality Assurance)

Vivekanand Education Society's College of Pharmacy, Chembur, Mumbai-400074.

Article History

Received - January 12th 2024 | Accepted - January 15th 2024 | Published February 2024

ABSTRACT

"Artificial Intelligence (AI)" can play a vital part in early detection of complications, promoting adherence to healthy lifestyle and pharmaceutical regimen, real-time monitoring for maintaining optimal glycemic status and providing predictive prognostic displays for a patient's diabetic status. The early identification and management of the complications (intense and inveterate) in diabetes significantly impacts the patients "quality of life (QoL)". The success of AI in early diabetic retinopathy diagnosis has paved the way for addressing other complications. While "Flash Glucose Monitoring (FGMs) and Continuous Glucose Monitoring (CGMs)" have not been used in routine clinical practice, these methods possess potential for future diabetes management. Leveraging large datasets, AI enables automated diagnosis of diabetic retinopathy and monitoring cardiovascular risk factors with improved sensitivity and specificity. The potential integration of smartphones and smart devices, along with dedicated applications, empowers patients to monitor and diagnose diabetes complications remotely, signifying a paradigm shift towards "e-disease management" in future. AI applications offer several advantages including greater accuracy, efficiency, user-friendliness, and satisfaction complementing long term management and early identification of diabetes-related complications in the long run.

Keywords: AI, diabetic retinopathy, flash glucose monitors, continuous glucose monitors, artificial neural

1. Introduction

"Intelligence" can be described as a blend of diverse abilities that has positioned humans at the forefront within the animal kingdom. According to the Cambridge dictionary intelligence is defined as "the ability to memorize, get it and draw conclusions".[1] Artificial Intelligence (AI) is a multidisciplinary field of computer science that focuses on creating systems capable of performing tasks that would typically require human intelligence. The ultimate goal of AI is to develop machines that can emulate and, in some cases, surpass human cognitive abilities such as learning, problem solving, reasoning, perception and natural language understanding. AI has been suitably characterized by Boden in 1977, as "it is the capacity to create computers that will perform specific tasks, that needs insights in the event that done by humans".[2]

The global burden of diabetes is witnessing a concerning escalation, marked by a substantial increase in prevalence across the globe. Both type 1 and type 2 diabetes contribute to this growing epidemic, with the latter closely tied to lifestyle factors such as sedentary behavior, unhealthy dietary patterns, and rising obesity rates. The implications of diabetes extend beyond individual health, encompassing significant economic and health care challenges. Complications associated with diabetes, including cardiovascular diseases, kidney failure, blindness and amputations contribute to the escalating burden. Low- and middle-income countries face additional hurdles in managing diabetes due to limited access to health resources. Mitigating this crisis is necessary. The role of technology, particularly Artificial Intelligence and digital health solutions is increasingly prominent in enhancing diabetes prevention, management, and care. As the prevalence of diabetes continues to rise, a proactive and comprehensive strategy is imperative to curb its impact and improve global health outcomes.[5]

AI holds immense potential in revolutionizing diabetes care, offering innovative solutions to address the rising global burden of this chronic condition. By leveraging advanced algorithms, AI enhances continuous glucose monitoring, providing real-time insights and personalized recommendations for insulin adjustments. Predictive modeling powered by AI identifies potential complications and forecasts blood glucose fluctuations, enabling timely interventions. In healthcare provider setting, AI contributes to treatment optimization through more precise decision support systems. Moreover, AI-driven solutions, such as mobile apps and wearable, promote patient engagement by offering real-time feedback and support for lifestyle modifications. As technology advances, the integration of AI in remote monitoring and telehealth platforms further enhances accessibility and comprehensive healthcare services, particularly for underserved populations. Embracing these AI-driven innovations not only improves the quality of diabetes care but also empowers individuals for more personalized and proactive self-management.[6,8]

AI techniques and the strategies which incorporate case-based reasoning and profound learning [naïve Bayes, arbitrary woodland], developmental computations and crossover brilliantly frameworks and fluffy rationale are being connected to medication and wellbeing. These strategies will be beneficial for healthcare professionals in tasks that involve the manipulation of data and information.[3] Smartphones can be utilized with improved cameras and biometric features create novel opportunities in the healthcare sector.

With an enormous diabetic population reaching '463 million people in 2019' a number projected to rise to an astonishing '700 million by 2045' and constituting for approximately 10% of global health expenditure, diabetes stands out as a major disease poised to derive advantages from the implementation of AI and cognitive computing.[5,6] AI can play pivotal role in addressing challenges including early identification of disease, continuous checking for glycemic status and providing displays for patient's diabetic condition.

2. Role of AI in diabetes

Managing this disease goes beyond merely controlling HbA1c levels; it involves prompt diagnosis, educating patients to avert complications (hypoglycemia, ketoacidosis, etc.) while also focusing on early recognition to mitigate further complications (e.g., retinopathy, stroke, cardiovascular diseases) to improve the quality of life. Different tools are employed for individuals with this disease, such as choosing treatment options or establishing therapeutic goals. These tools have been demonstrated to enhance the quality of decision-making and facilitating information exchange.[7] Substantial information can be generated by individuals, it can be extensive up to one million gigabytes.

Progress of this technique shows potential offering providing database for individuals who have this disease. Sophisticated methods employed produce a huge dataset known as a 'digitosome' and this when integrated with clinical data, can be highly beneficial for automated analysis and pattern recognition.[8] Exploring the utilization of this technique for data management, creation of novel tools for this disease management is under exploration and shows promise for the near future. The integration of wearable devices and smartphones has significant impact on and enhances comprehensive insights for the well-being of patients with diabetes, healthcare professionals, and the healthcare system. The different aspects being investigated for the application of digital methods encompass the utilization of mobile applications, algorithms which are AI-based, FGM, closed-loop systems, and online communities. Compared to other chronic conditions, self-monitoring plays a vital role in diabetes, generating extensive information and biomarkers for electronic-health devices to monitor patterns and utilize in lifestyle modifications and interventional planning.

3. How does AI work?

The working of AI involves various approaches and techniques, with machine learning and deep learning being prominent components. The different approaches include:

1. Case-based Reasoning (CBR)
2. Machine Learning and Deep Learning
3. Miscellaneous

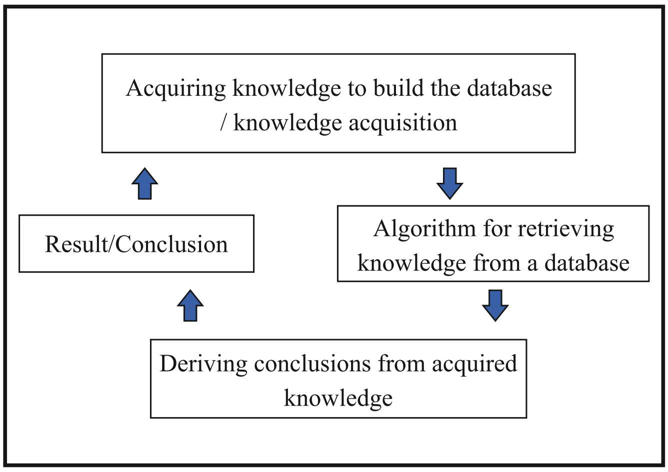

Figure 1: A simplified approach to comprehending the fundamental principle of AI

3.1 Case-based reasoning

It is a computer-based process which involves learning from previous similar experiences to address new problems and this approach is widely used in managing diabetes to optimize and personalize insulin therapy for various meals.[11] The system aims to automatically identify issues responsible for blood glucose control, give solutions for the identified issues and remember information about both effective and ineffective solutions for individual patients. The "4 Diabetes support system" serves as an illustration of a solution applied in diabetes care; designed to automate and alleviate the challenge of an individualized approach to blood glucose management.[12]

3.2 Machine learning and Deep learning

The approach involves diverse processes, such as AAN's, vector machines, decision tress, naïve bayes, classification and regression trees, random forests, and k-nearest neighbors.[4] Its purpose is to automatically screen blood glucose levels and helps in identifying individuals with this disease at a high risk.[12] Artificial Neural Networks plays a role in diagnosing diabetes and evaluating the influence of variables on glycemic indices to generate individualized results.[14]

3.3 Miscellaneous methods

The method of "back vector relapse" has been applied to detect indicators of hypoglycemia, providing alerts to patients during significant hypoglycemic events. To allow computers to automatically memorize known information without human intervention, intricate convolutional neural networks (such as evolutionary algorithms, Kalman filter, deep learning, etc.) are initially presented with the data. Subsequently, algorithms are devised to retrieve data from the database, aiding the computer in distinguishing crucial information through a process called KDD. Conclusions can be further drawn from the acquired database that involves deduction and the generation of inferences. These ultimate conclusions can be helpful for further reference.

4. AI in administration of complications in diabetes

4.1 Hypoglycemia, Hyperglycemia

Timely identification and effective management of complication of both intense and inveterate, in diabetes have a large impact on a patient's quality of life. The positive outcomes of AI in promptly diagnosing diabetic retinopathy have broadened the horizons for managing various other complications. Commonly available technologies like "Flash Glucose Monitors (FGMs) and Continuous Glucose Monitors (CGMs)" have shown potential in effectively managing glucose levels, in both the type of diabetes.[8] Research involving CGM devices, such as the Freestyle Libre has indicated that current assessment of glycemic changes can contribute fluctuations and overall glycemic management, particularly in individuals with insulin injections.[15] CGM has proven to be more effective than FGMs in predicting hypoglycemia. When integrated with an insulin pump, it creates the potential for a closed-loop insulin method referred to as an artificial pancreas, exemplified by technologies like Diabeloop, holding promise for type 1 and insulin-dependent type 2 diabetes. This integrated approach not only improves patient outcomes but also has the potential to reduce overall healthcare costs associated with diabetes management.

4.2 Diabetic Retinopathy, Edema

Diabetic retinopathy (DR) stands as primary cause of visual impairment, necessitating yearly retinal examination. However, this process has limitations, requiring a specialized professional and the use of mydriatics, which restricts the patient's activities on the examination day.[16] Advancements in automated diagnosis now offer solutions for DR and cardiovascular risk factor monitoring. Recently, FDA granted approval for IDx-DR which employs a computer program utilizing AI algorithms to diagnose images captured with a retinal camera called Topocan NW400, classifying different types of retinopathies.[5] Medios Technologies algorithm presents a promising software for screening of DR, compatible with smartphone-based Remidio non-mydriatic fundus-on-phone camera, demonstrating a greater accuracy.[18]

4.3 Choice boost in Clinical practice

Machine learning can be employed to predict both "short-term as well as long-term HbA1c" responses at the commencement of insulin therapy in individuals with Type 2 diabetes.

4.4 Other uses

Additional applications are outlined as follows:

- Utilization of the healthcare recommendation system for population risk stratification to predict the likelihood of diabetes, leveraging extensive data information
- Genomics: Utilizing microbiome data has contributed to the establishment of a repository containing a variety of microbial marker genes, assisting in the prediction of future diabetes onset
- Increasing patient's self-awareness and treatment through the incorporation of mobile apps
- Enables tracking of disease status, allowing healthcare providers to track vital parameters and intervene promptly when needed through automated real-time monitoring devices
- Tools for tracking lifestyle modifications: Wearable devices such as smart bands and smart scales

Now-a-days AI holds promising in assisting physicians with decision-making and customizing diabetes management for individual patients, ensuring adherence to treatment and ultimately leading improved health outcomes. The exploration of non-invasive diabetes diagnosis and the monitoring diabetic neuropathy and wounds is under exploration using AI-assisted devices, and they are expected to be commercially available in the near future.[20]

5. Conclusion

It marks the inception of a new era where AI is being implemented for healthcare needs. AI applications provide increased accuracy, efficiency, user-friendliness, and satisfaction for individuals with diabetes (PWDs), their healthcare providers, family, and caregivers. A notable challenge that AI will face is the difficulty in replicating AI from published data, as much of the source code is not publicly accessible, demanding more transparency in data sharing. The management of diabetes has evolved from the localized tracking of blood glucose and HbA1c to the creation of intelligent data for improving both individual patient outcomes and the overall population of individuals with diabetes. Smartphones and intelligent devices have the potential to transform diabetes management, making it accessible to every patient through a simple touch on the screen, creating an "e-disease". Despite these advancements, it is crucial to acknowledge that AI should complement existing practices but can never entirely substitute the efforts undertaken in clinical settings for diabetes management.

6. References

1. Merriam-Webster, Intelligence. In Merriam-Webster. com dictionary. Retrieved November 11, 2020,

2. Boden, Margaret, "Artificial intelligence and natural man", Synthese, 1980; 43(3)

3. Ramesh, A. N., Kambhampati, C., Monson, J. R., & Drew, P. J, Artificial intelligence in medicine, Annals, 2004; 86(5):334.

4. Ellahham S. Artificial intelligence: the future for diabetes care. Am J Med. 2020; 133(8): 895–900

5. Dankwa-Mullan I, Rivo M, Sepulveda M, et al. Transforming diabetes care through artificial intelligence: the future is here. Popul Health Manag. 2019; 22(3): 229–242

6. Ramesh AN, Kambhampati C, Monson JRT, et al. Artificial intelligence in medicine. Annals, 2004; 86(5): 334–338.

7. Ellahham S, Artificial intelligence: the future for diabetes care, Am J Med, 2020; 133(8): 895–900.

8. Dankwa-Mullan I, Rivo M, Sepulveda M, et al, Transforming diabetes care through artificial intelligence: the future is here, Population Health Management, 2019; 22(3): 229–242,

9. Thomas RL, Halim S, Gurudas S, et al. IDF diabetes atlas: a review of studies utilising retinal photography on the global prevalence of diabetes related retinopathy between 2015 and 2018, Diabetes Res Clin Pract, 2019; 157: 107840

10. Karagiannis T, Andreadis P, Manolopoulos A, et al. Decision aids for people with Type 2 diabetes mellitus: an effectiveness rapid review and meta-analysis. Diabet Med. 2019; 36(5): 557–568.

11. Fagherazzi G, Ravaud P. Digital diabetes: Perspectives for diabetes prevention, management and research. Diabetes Metab. 2019; 45(4): 322–329.

12. McConnell MV, Shcherbina A, Pavlovic A, et al. Feasibility of obtaining measures of lifestyle from a smartphone app: the myheart counts cardiovascular health study. JAMA Cardiol, 2017; 2(1): 67–76.

13. Zhang J, Xu J, Hu X, et al. Diagnostic method of diabetes based on support vector machine and tongue images. Biomed Res Int, 2017; 2017: 7961494.

14. Marling C, Wiley M, Bunescu R, et al. Emerging applications for intelligent diabetes management. AI Magazine, 2012; 33(2): 67.

15. Schmidt R, Montani S, Bellazzi R, et al. Cased-Based reasoning for medical knowledge-based systems. Int J Med Inform, 2001; 64(2-3): 355–367.

16. Buch V, Varughese G, Maruthappu M. Artificial intelligence in diabetes care. Diabet Med, 2018; 35(4): 495–497.

17. Odedra D, Samanta S, Vidyarthi AS. Computational intelligence in early diabetes diagnosis: a review. Rev Diabet Stud. 2010; 7(4): 252– 262.

18. Feig DS, Donovan LE, Corcoy R, et al. Continuous glucose monitor ing in pregnant women with type 1 diabetes (CONCEPTT): a mul- ticentre international randomised controlled trial. Lancet. 2017; 390(10110): 2347–2359.

19. Gulshan V, Peng L, Coram M, et al. Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA. 2016; 316(22): 2402–2410.

20. Ting DS, Cheung CYL, Lim G, et al. Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes. JAMA. 2017; 318(22): 2211–2223.

21. Sosale B, Aravind SR, Murthy H, et al. Simple, mobile-based artifi- cial intelligence algoithm in the detection of diabetic retinopathy (SMART) study. BMJ Open Diabetes Res Care. 2020; 8(1)

23. Nagaraj SB, Sidorenkov G, van Boven J, et al. Predicting short- and long-term glycated haemoglobin response after insulin initiation in patients with type 2 diabetes mellitus using machine-learning algorithms, Diabetes Obes Metab. 2019; 21(12): 2704–2711.

23. Han W, Ye Y. A repository of microbial marker genes related to human health and diseases for host phenotype prediction using microbiome data. . Pac Symp Biocomput, 2019; 24: 236–247.

24. Rahmani Katigari M, Ayatollahi H, Malek M, et al. Fuzzy expert system for diagnosing diabetic neuropathy. World J Diabetes. 2017; 8(2): 80–88.

25. Wang L, Pedersen PC, Strong DM, et al. An automatic assessment system of diabetic foot ulcers based on wound area determination, color segmentation, and healing score evaluation. J Diabetes Sci Technol. 2015; 10(2): 421–428.