Guest Editorial

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Diabetes and Artificial Intelligence

Several innovative advances in the field of science and technology are going to be integral to the lives of subjects living with diabetes. These innovations improve the QoL (quality of life) by decreasing mortality and morbidity significantly. Intelligent closed loop insulin pumps (artificial pancreas), non-invasive glucose sensors are concepts, already established in the field of diabetes management. Artificial intelligence (AI) is also a rapidly emerging tool for managing diabetes more efficiently. AI enables computers to sort problems by synchronous use of these innovations which otherwise require human intelligence. In fact, AI is a branch of computer science that aims to create systems or methods that analyze information and allow the handling of complexity in a wide range of applications without direct human intervention[1].

Diabetes mellitus is one of the most prevalent chronic diseases associated with multi-organ morbidity and significant mortality. The hallmark of diabetes is dysregulation of glucose homeostasis. AI methods in combination with the latest technologies, including medical devices, mobile computing, and sensor technologies, have the potential to enable the creation and delivery of better management services to deal with chronic diseases like diabetes[1].

How does AI Operate Conceptually ?

The application of AI algorithm is highly complex and involves technical and specialized knowledge. In brief, the first and most important part of this method is acquiring information which is popularly known as 'Learning from Knowledge'[1]. This allows computers to learn automatically without human intervention or assistance. To enable this learning, several methods or techniques are used eg, artificial neural networks, deep learning, decision trees, regression algorithms, reinforcement learning etc. The next step is 'exploration and creation of algorithms' after retrieving potential information from these databases and this is popularly known as knowledge discovery databases (KDD)[1]. In the third stage precise and effective ways are created based on reasoning from KDD and involves logical techniques such as deduction to generate conclusions[1].

Applications of AI in Diabetes: The primary areas where applications of AI are being currently evaluated in diabetes management are several[1,2]. These are in : (i) deciding blood glucose control strategies, (ii) predicting blood glucose, (iii) detecting adverse glycemic events, (iv) calculating insulin bolus, (v) determining risk and patient personalization, (vi) detecting faults and (vii) lifestyle and daily-life support in diabetes management and so on.

Continuous glucose monitoring devices in association with artificial pancreas (a closed loop insulin pump including a glucose sensor and algorithm based insulin infusion device[3]) will have the key role in the near future to improve overall diabetes management and to reduce the frequency of severe

hypoglycaemia especially in subjects with Type1 Diabetes[3]. The algorithms are based on traditional control engineering relying on either real patient's data or virtual / computer generated patient data. However AI technique in this situation uses alternative methodology to create algorithm[1]. Though there are several methodologies, the most common that is being investigated is FL (Fuzzy Logic technique)[1]. Though this fuzzy logic system has not yet been proved superior to classic algorithm, it has the ability to deal with non-linearity or uncertainty. In the feasibility trials, fuzzy method was able to improve nocturnal blood sugar control without increasing the risk of hypoglycaemia[1]. Other AI methods which are being investigated for this purpose use RL (Reinforcement Learning) or ANN (Artificial Neural Network)[1].

Excursion of blood sugar or glycemic variability is a sign of poor diabetic control. To detect this variability in real time fashion, one has to depend on CGMS with its limitations. AI techniques in the long run would be able to predict blood sugar values which could effectively prevent long term complications. ANN (Artificial Neural Network) approach in this regard, is the most widely applied methodology, but other machine learning methodologies are also being investigated[1]. Similarly, AI methods can predict episodes of extreme hyperglycaemic and hypoglycaemic fluctuations allowing the subjects or physician to act in advance to prevent any hazardous effects out of these extreme excursions[1].

Predicting and calculating bolus dose of insulin while using an insulin pump is another area where AI can have major impact in maintaining euglycemia. Presently, the mainstay to help remove the stress and guess work for rapid acting insulin is using a bolus advisor. Bolus advisors, also known as bolus calculators, are incorporated into pump technology and make the process much simpler. Bolus advisors do this by taking a few things into account: blood glucose level, target blood glucose level and carbohydrate consumption. It also takes into account any insulin still working from a previous bolus (injection of rapid acting insulin). However these bolus advisors are not free from error which may include selection of physiologically inappropriate bolus advisor settings, the use of short duration of insulin action times etc. AI has been used to provide sets of tools to improve the accuracy of carbohydrate count and to calculate the optimal insulin bolus for an ingested meal. Case-Based Reasoning (CBR) methodology has been used in this context and extensively studied at the Imperial College London[1,3]. Clinical trial has also been performed to validate their approach to manage various clinical scenarios. This approach was also demonstrated to improve glycaemic control in diabetes management when it was combined with a closed loop system. Similarly an algorithm termed as GoCARB which provides dietary advice to diabetic patients based on automatic carbohydrate counting, is being investigated by researchers at Switzerland[1]. This system uses computer vision techniques, such as feature extraction and SVM (support vector machine, another AI technology) and initial small 'proof of concept' studies show it to be an excellent assistive tool[1].

Not all subjects with diabetes are at similar risk for all the chronic diabetic complications. Presently risk factor based clinical approach or risk engine based stratification identifies the subset of patients at particular risk for a particular complication. An important step toward is to have better risk detection and intervention tailored to each and every individual separately. AI methodologies like ANN, hierarchical clustering, genetic algorithm like K-means are being evaluated more and more to stratify according to the diabetic complications eg, neuropathy, nephropathy and especially retinopathy[1,3].

Type 1 patients use CGM devices to calculate insulin infusion rates. Consequently, failure of these devices can lead to episodes of hyperglycaemia or hypoglycaemia. AI approach using SVM is shown to be able to detect correct and incorrect measurements in real-time CGM. Another AI technology KNN (k-nearest neighbour algorithm) is also being tried to diagnose faults in CGM technology[1].

Apart from these, using deep learning algorithms of AI, automated diagnosis of diabetic retinopathy (DR) and cardiovascular risk factor monitoring are now possible, which are based on large retinal fundus imaging datasets. Other AI algorithms is also likely be integrated into smart telemedicine devices and be increasingly used to provide personalized preventative programmes, as well as personalized diabetes management adapted to patients lifestyles, treatments, genetic backgrounds and environments[1,4].

So in conclusion, Artificial Intelligence (AI) in near future is going to have a tremendous impact in management of one of the most prevalent non communicable disease, diabetes mellitus.

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