Review Article

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Artificial Intelligence Drives Diabetes Care

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Introduction

Artificial intelligence (AI) is a technology used to explore, gather information, apply data, and extract conclusions from electronic medical data and is truly transforming healthcare. In diabetes care, AI has proven to help with the identification, classification, diagnosis and management of DM and has provided and continues to provide clear insight and potential opportunities for the detection of undiscovered solutions. In the field of diabetes, AI has already been applied in the prediction of the disorder, dietary and exercise guidance, insulin guidance, monitoring of complications, and self-management. With the broadened use of continuous glucose monitoring and identifying the patterns of glucose variability, an extensive amount of digital data is now available, allowing us to reform the perspective of the management of diabetes and other chronic conditions. It has paved the way to conduct extensive research on various influences of diabetes management and other things like nutrition, sleep and activity.

Redefining the classification of Diabetes:

Artificial intelligence has allowed us to understand and predict those at high risk of developing diabetes and assess high-risk algorithms to shape and address the preventive care required with the help of electronic medical records. With a comprehensive look into various glucose readings and analyzing CGM readings, the classification and efficient prediction of diabetes in an individual may change shortly. The stringent glycemic levels and trends to predict prediabetes and diabetes at a much earlier stage in significantly more patients, with risk factors and the evolution of diabetes at its earlier stages by targeting precision care may unfold in times ahead.

With the help of AI and utilization and advances of genetic testing and autoantibody testing, mutations in genes that cause MODY (monogenic diabetes) and genetic syndromes (K-ATP channel mutations in KCNJ11, ABCC8), GATA6, PDX1 GATA6 and PDX1 needed for pancreatic development, FOXP3 mutations that cause a monogenic form of autoimmune diabetes, as part of IPEX syndrome can also be detected by analysing the sequence of the affected gene and look for the further specific variants that cause the syndrome. With the help of these tools which was once just classified as newborn/childhood-onset diabetes, new approaches have emerged changing the prospect of diagnosis, some cases management and identifying research therapeutics for these conditions.

Dietary algorithms:

AI has impacted dietary changes and allowed one to reason about the impact of carbohydrates, protein and fat in relation to glucose trends. The significance of carbohydrate intake on blood glucose levels has been well established, allowing us to change dietary guidelines recommended for diabetic patients. By allowing us to calculate the amount of carbohydrates needed to cause a spike in blood glucose levels and the amount of protein and fat needed to reduce blood sugar levels, a guideline has been composed for diabetic diets.

In type 1 diabetes, the use of insulin pumps and CGMs carbohydrate counting, calculating insulin to carbohydrate ratios, and predicting insulin dose for each meal for individual patient needs has proved vital and a life-changing gateway for managing diabetes.

AI has already paved the way for dietary intervention in diabetes by analyzing an individual with CGM, a simultaneous discussion about a diet diary from a patient can be receptive to the physician and the patient to analyze individual responses. Detailed understanding of the individual diets, compliance to diabetic diet intervention, the understanding of time of intake of food in relation to blood glucose, impact of deviation from following diets on blood glucose and impact on periods of fasting and overeating on blood glucose levels and much more can be understood.

CGM and Blood glucose variability Prediction:

AI with the use of continuous glucose monitoring has allowed us to predict glycemic control such as hypoglycaemia and hyperglycaemia. As a pose to the traditional methods of monitoring blood glucose levels, continuous glucose monitoring has been a paradigm in the accurate understanding and analysis of individual blood glucose fluctuations. Without AI and the help of CGM, a significant amount of data collected between what is usually measured in the lab (fasting and postprandial glucose levels), a complete and thorough evaluation of the individual responses to medications, prediction of a low blood glucose level based on trends and setting an intervention such as an alarm in the device or app to notify the individual which has been transformative would not have been present.

Another extremely important concept of precision diabetes which focuses on blood glucose levels between other readings, an important concept of glucose variability was discovered. Today with the help of AI, identifying the importance of glucose variability and its particular crucial role in oxidative stress and fat accumulation has been crucial in diabetes education, which only emphasizes diet, lifestyle control and the development of diabetes-related morbidity. We now know that much of how active one is, diet, menstrual cycles, sleep patterns, stress levels, and behaviours such as alcohol consumption or smoking may have a crucial impact on glucose variability. The significance of preventing variability which has been associated with fat gain has been backed up by studies that state that glycemic variability that is below 12% is what is considered ideal. Glycemic variability is close to becoming a future target parameter for optimal glycemic control, all with the help of AI.

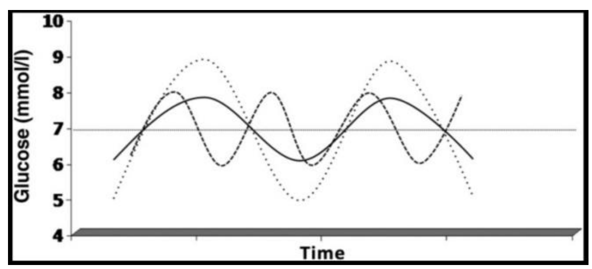


Figure: 1 Visualization of glucose variability

With the use of CGM, patients who experience the Somogi effect and Dawn phenomenon has been captured and by being able to differentiate between the two effects and providing timely intervention to help change diet and therapeutic intervention, it has been extremely functional. This enormous data along with consulting with individual patient activity levels and stress with self-recorded journals has proved to be an effective and instrumental tool in understanding specific interventions for lifestyle changes and therapeutic importance. It has allowed us to identify the relationship between medications and insulin and accurately being able to predict alternate medications for the next line of therapy or adjust insulin levels accordingly.

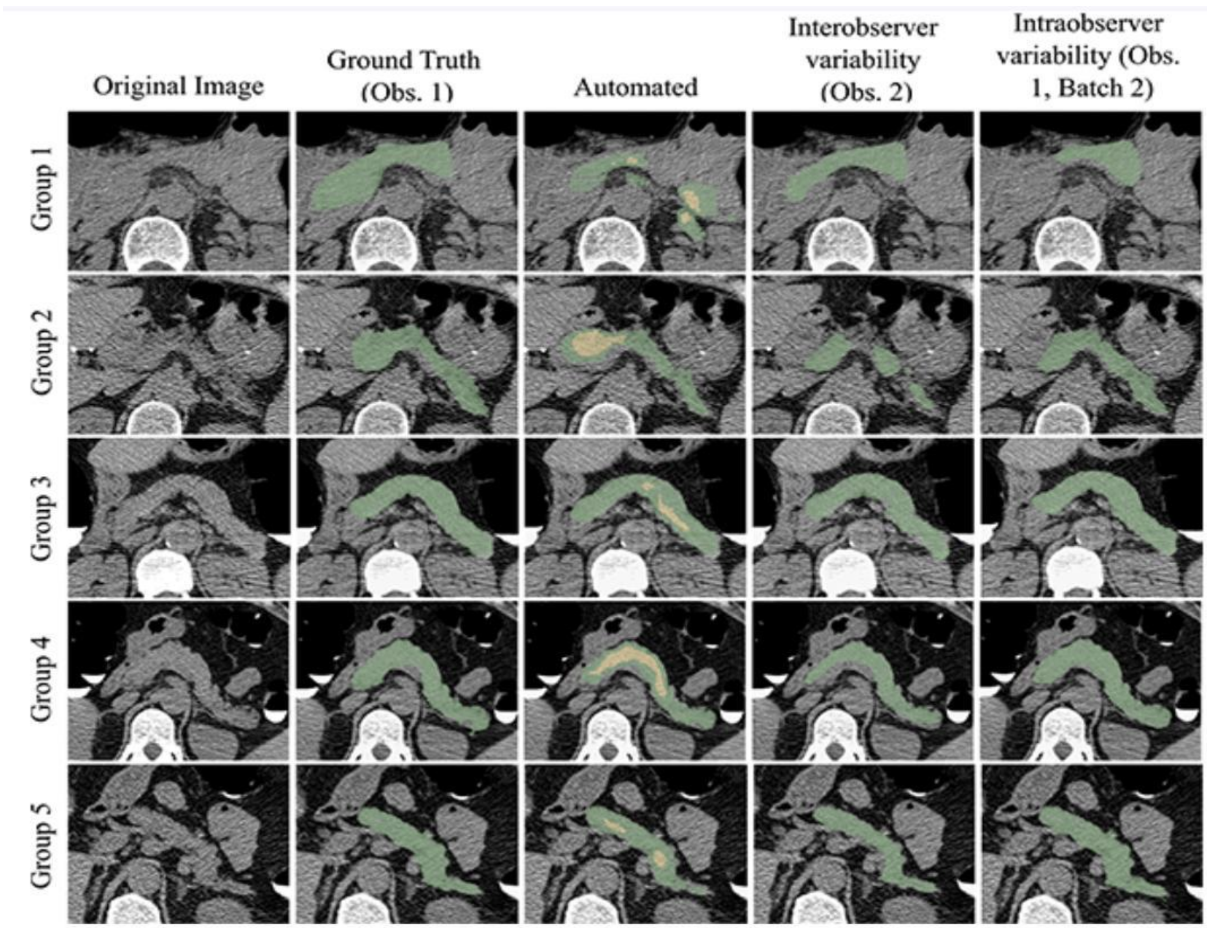
Application in vascular disease:

With more data collection of enormous readings, predictability of diabetic vascular complications such as diabetic retinopathy with the use of detailed retinal fundal images and being the ability to classify stages of retinopathy, it proves valuable in preventive and therapeutic management. Predicting the development of other microvascular complications such as nephropathy, or neuropathy or a macrovascular complication such as a cardiovascular event can be done with clinical and biochemical data. Similarly, in diabetic nephropathy, colonization of ultrasound and Doppler together can be used to assess endothelial dysfunction and microvascular impairment in the kidneys of diabetic patients.

AI has been used in identifying and measuring the carotid intima-media thickness and plaque area on carotid vascular images providing a vascular risk stratification tool in cerebrovascular disease. Similarly in peripheral artery disease the application of ankle-brachial index for the diagnosis of PAD, and aortic artery imaging for detecting aortic aneurysms.

Imaging and Predicting Diabetes:

In addition, AI has proven to play a vital role in the diagnosis and early detection of diabetes with the use of extrapancreatic and



Tallam et al, Radiology 2022; 000:1-11 ©RSNA 2022 pancreatic CT Image findings. Just by improving the automated clinical imaging technology, a better-enhanced view of the pancreas and the amount of visceral fat around the organs may be used to accurately distinguish patients with and without diabetes and patients with diabetes were found to have lower pancreas density. With more accurate and defined imaging advances, a non-invasive mode of predicting and diagnosing the condition can be utilized.

Pancreas segmentation in patients from each of the five visceral fat groups. Segmentation performance is better for patients with higher visceral fat (group 5 being the highest). Visceral fat percentages at the L1 level for the specific patients shown here were 9.81% in group 1, 13.72% in group 2, 20.19% in group 3, 27.88% in group 4, and 32.42% in group 5; The green area indicates full segmentation and the yellow area indicates segmentation after erosion. Obs. = observer.

Summary:

AI is serving as an educational tool and therapeutic tool that will for years to come change the quality of disease management. From CGMS to imaging modalities, machine learning is a tool we should not shy away from strategic use. AI uses integrative care with comprehensive analysis and algorithms which will be crucial to reduce disease burden and help bring down diabetes-related morbidity. It is changing the interpretation and management of diabetes from what it was earlier by targeting precision medicine care which has proven to be extremely strategic and is a refinement to how we practise today.

Resources:

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