ISSN 2564-324X

SHORT COMMUNICATION

Revolutionary Role of Stem Cell Therapy Coupled with Modern AI Based Technologies in Diabetes Management and Remission

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Warrier R. Revolutionary Role of Stem Cell Therapy Coupled with Modern AI Based Technologies in Diabetes Management and Remission. Int J Diabetes Manag. 2024;3(1):03-07.

Abstract

Type 2 diabetes is a chronic metabolic disorder characterized by high blood sugar levels over a prolonged period. It is a significant global health issue, affecting millions of people worldwide. The traditional treatment for diabetes involves medication, lifestyle changes, and regular monitoring of blood sugar levels to decide on treatment modifications accordingly. However, recent advancements in modern technologies/techniques involving artificial intelligence (AI) and stem cell therapy have shown promising results in achieving excellent diabetes care outcomes and even remission, which was never conceivable a few decades ago. AI-driven interventions enable the development of tailored treatment plans, leveraging patient data to optimize glycaemic control and predict complications. Whole Body Digital Twin (WBDT) models provide holistic insights, facilitating significant rates of diabetes remission. Stem cell therapy when coupled with newer technologies has shown to be revolutionary towards this. Especially therapies targeting the mammalian Target of Rapamycin (mTOR) pathway show a great potential for regenerating damaged pancreatic beta cells and improving insulin production. However, challenges such as data privacy concerns with AI models utilising big data and ethical considerations in stem cell research persist; there is a need for regulatory norms towards this especially with the availability of these advanced treatment modalities, which would be the face of medical science in the coming years. For sure, combining AI and stem cell-based therapies present an innovative approach to enhance diabetes management, enabling the identification of suitable candidates for treatment and predicting treatment success. Diabetes was considered a lifelong disease that carried a huge burden of secondary organ complications over a period. This manuscript explores the potential of these innovative approaches in treating diabetes and discusses the scientific evidence supporting their utility.

Key Words: *Diabetes management; Stem cell therapy; Blood sugar levels; Medication*

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Received: March 11, 2024, Accepted: March 25, 2024, Published: April 18, 2024

Introduction

Diabetes is a complex disease that affects the body's ability to regulate blood sugar levels. It can lead to various complications, including heart disease, kidney damage, and nerve damage (peripheral and autonomic neuropathy) carrying the highest rate of morbidity and mortality. The conventional treatment for diabetes involves medication, lifestyle changes, and regular monitoring of blood sugar levels. However, these methods often best targeted to manage the condition to the best possible extent only, and never towards achieving complete remission, and patients may require lifelong management with these medications. In addition, only a fraction of diabetes patients is able to achieve glycaemic target of HbA1c 7% in spite of the newer drugs available currently in the armamentarium [1]. Recent advancements in AI and stem cell therapy have shown potential in managing diabetes and even achieving remission. AI based intervention can help in personalized treatment plans, while stem cell therapy can regenerate damaged cells and tissues. This manuscript explores the utility of these innovative approaches in managing diabetes care and discusses the scientific evidence supporting their use.

AI in Diabetes Management

AI has the potential to revolutionize diabetes management by providing personalized treatment plans based on individual patient data. Machine learning algorithms can analyse large amounts of data, including medical history, lifestyle habits, and genetic information, to identify patterns and predict future outcomes. This information can then be used to develop tailored treatment plans that optimize patient outcomes. Advancements in AI models include development and utilisation of Whole Body Digital Twin (WBDT) models that help understand the core metabolic picture of every type 2 diabetes patient and thereby develop a precision treatment plan in terms of nutrition, activity, sleep, breathing etc. When these precision requirements are met, the patient is able to come back to his/her best state of health since the body is repairing itself in a holistic manner. Even up to 84% of patients who participated in a RCT primarily utilising WBDT as a diabetes remission technology were able to achieve diabetes remission as per ADA criteria HbA1c<6.5% and maintained for at least 3 months) just by 180 days completion into the trial [2]. In the history of diabetes, this result is a standalone milestone for the first time ever and would pave the way further for these revolutionary technologies to make difference to the human population.

AI-based decision support systems have also improved glycaemic control in patients with type 2 diabetes. These systems analysed patient data, including blood sugar levels, medication adherence, and lifestyle habits, to provide personalized recommendations for treatment adjustments; the health care professional takes the final decision on the medication changes. These results showed significant improvements in glycaemic control and a reduction in HbA1c levels (a measure of long-term blood sugar control) [3]. AI based models have been very useful in terms of determining and delivering precision and personalized medicine; we know that the same treatment can deliver different outcomes for different patients. This is phenotype and genotype dependant. Hence, with the use of AI based models, especially when it's combined with genetic mapping technology, can deliver treatment protocol very specific for every patient, which is the hallmark of precision and personalized medicine. Also, with the massive database upon which some of the sophisticated

AI's are built, they can predict the possibility of secondary complications associated with susceptible cohort of diabetes patients, even many years before the complication could potentially set in. This can help develop personalized treatment plans that when adopted can prevent the onset of these complications long term. A prime example of such a model that's commonly used is AI based diabetic retinopathy algorithms, where prediction of possible retinopathy can be done based on very early retinopathy changes in the initial images. In fact, the penetration of this technology is excellent where in remote settings, these AI based models can give excellent suggestions for the primary health care provider, where availability of retina specialists might be a challenge [4].

Recent advancements in AI models, including the diabetes remission programs as discussed above have been able to develop Digital Twin models (WBDT) that guides every patient to achieve holistic improvement in health. At the molecular level, various speculations have been attributed that is resulting in these outcomes; this includes healthy regulation of the Mammalian target of Rapamycin (mTOR) pathway resulting in reduction of inflammation and insulin resistance. This allows the 'mitochondrial switching' between pathogenic and healthy state as part of the metabolic repair; dysregulation of the mTORC1 has shown to play a crucial role even in development of cancer [5]

Potential Challenges with AI Based Healthcare Interventions

One of the major challenges with modern AI technology-based interventions is the data privacy, especially when there is a breach in the system that could potentially lead to loss of patient data that are supposed to be highly sensitive and confidential. Since big tech companies are the major players in the evolving healthcare industry, we need to ensure that all appropriate measures are taken to prevent data breach. With the HIPAA compliance in place, there is definitely a process in place towards this, but much more emphasis has to be placed on this since AI based medicine is going to be the dictum in the future. Regulations should include appropriate oversight of big data and should be the norm [6].

Stem Cell Therapy in Diabetes Remission and role of mTOR pathway

Stem cell therapy involves the use of stem cells to regenerate damaged cells and tissues. In the context of diabetes, stem cells can be used to repair damaged pancreatic beta cells, which are responsible for producing insulin. This can lead to improved insulin production and better blood sugar control. Mammalian Target of Rapamycin (mTOR) pathway has shown to be crucial in stem cell maintenance and differentiation, especially with the Embryonic Stem cells. It has shown to play an important role determining health versus disease. Studies have shown that mTORC1 plays a crucial role in promoting the inflammation, oxidative stress and secondary complications in diabetes. Also, many cancers have been implicated in dysregulated mTOR pathway. Hence newer targets addressing this needs to be developed for better diabetes management [7].

Early data using embryonic stem cells has shown promise to some extent. Transplanted human embryonic stem cell-derived pancreatic beta cells into diabetic mice and pig models have shown significant improvements in blood sugar control and a reduction in insulin requirements. Yet, stem cell transplantation remains a procedure with less reliable results

currently in humans, where certain protocols involving transplanting stem cells into the portal vein have been attempted. At least 50% of the patients again became insulin dependent post 5 years procedure [8]. Few challenges include ethical issues concerning the use of embryonic stem cells; as a step forward, the availability of induced pluripotent stem cells (iPSC) has helped to harness the same benefits as ESC to a great extent. Yet, the lack of adequate number of capable cells that can secrete and sustain insulin levels to the extent needed remains a challenge resulting in failure of transplant over a period. The authors here suggest that usage of umbilical stem cells or mesenchymal stem cells could be a more viable alternative resulting in more robust outcomes.

A recent meta-analysis has shown that mesenchymal stem cell transplantation was safe and efficacious in reducing the baseline HbA1c and also resulted in higher c-peptide scores suggestive of better pancreatic health, in both type 1 and type 2 diabetes, although there is a suggestion that further studies are needed to understand the long-term implications of this therapy [9]

The probable mechanisms of how stem cell transplant benefits remain unclear, but speculation is that the pluripotent and totipotent capacity of stem cells is responsible for differentiation of these cells towards Human Embryonic Stem Cell-Derived Pancreatic Endoderm (hESC-PE) [10]and inhibition of cytotoxic T cells in the beta cells [11]

Combining AI and Stem Cell Therapy

Combining AI and stem cell therapy has the potential to further enhance diabetes management and remission. AI can play a significant role in identifying patients who are most likely to benefit from stem cell therapy based on the pathogenic pathway involved for every patient; these models work on pattern recognition utilising massive amounts of data which can help understand which cohort may respond best to a particular treatment protocol. When this is utilized towards a targeted approach to therapy with stem cells, more robust outcomes could be achieved.

A study published recently explored the use of AI in predicting the success of stem cell therapy in patients with type 1 diabetes. The machine learning algorithm analysed patient specific phenotypic data, including age, sex, duration of diabetes, and HbA1c levels, to predict the likelihood of successful stem cell transplantation. The results showed that the model accurately predicted the success of stem cell therapy in majority of patients.

Conclusion

In conclusion, AI and stem cell therapy show promising results in managing diabetes and achieving remission. AI can provide personalized treatment plans based on individual patient data, while stem cell therapy can regenerate damaged cells and tissues with profound immunomodulatory effects. Combining these innovative approaches has the potential to further enhance diabetes management and improve patient outcomes, even helping patients achieve long lasting diabetes remission. As research continues to advance, it is likely that AI and stem cell therapy will play an increasingly significant role in the treatment of diabetes.

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