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Artificial intelligence and improvement of stem cell delivery in healthcare

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ABSTRACT

Artificial intelligence (AI) is critical for improving the quality of stem cell manufacturing and delivery. AI can assist in determining the viability, effectiveness, efficacy, and safety of stem cells. Furthermore, in stem cell and regenerative medicine, AI is utilized to streamline simulation and model-building processes and find connections between cellular activities and their microenvironments. However, thoughtful consideration is required to minimize unwanted implications of AI incorporation for stem cell-based treatment.

Keywords: artificial intelligence, stem cell, tissue engineering

INTRODUCTION

In recent years, stem cell therapy has drawn considerable interest. These cells have the potential to multiply and specialize into diverse tissues, as well as the capacity to self-renew. Stem cells have totipotent, pluripotent, multipotent, or unipotent capabilities, based on the classification, and are considered the backbone of regenerative medicine [1]. It is being researched to treat an array of conditions, including autoimmune, metabolic, congenital, cardiovascular, musculoskeletal, and liver illnesses, that cannot be fully managed by existing drugs. Before the entire potential of stem cell and regenerative medicine can be realized, there are still obstacles and limitations that must be overcome, particularly in the areas of technology, society, regulation, and ethics.

The incorporation of artificial intelligence (AI), an evolving topic at the intersection of engineering and computational technology, is crucial and useful for overcoming these challenges. AI, which is a compilation of several interconnected modalities like deep learning (DL), machine learning (ML), supervised learning (SL), and unsupervised learning (UL), has been implemented to help in a variety of assignments of healthcare delivery, from aiding physicians with identifying diseases to personalizing treatment towards predicting patients' outcomes. Occasionally, the results demonstrate that AI may surpass medical specialists' evaluations [2]. Using an AI-driven manufacturing technique can aid in determining stem cells' sustainability, performance, efficacy, and safety before they are supplied to patients. It can also offer an improved framework for figuring out the best conditions for the growth of stem cells. Additionally, AI could deal with the intricate situations in regenerative therapy that might be susceptible to mistakes related to human error [3].

ARTIFICIAL INTELLIGENCE AND STEM CELLS

Data analysis and prediction using AI approaches, including machine learning-support vector machine (ML-SVM), data mining (DM), and deep learning-convolutional neural network (DL-CNN), are being employed progressively in regenerative medicine discipline [4]. These algorithms may hold the key to developing a formulation for the therapy. This has led to high hopes for AI, which has developed into an accompanying technology that enhances human competence [3]. The most notable applications of AI in regenerative medicine include the recent utilization of computational frameworks based on artificial neural networks for performing intricate tissue engineering assignments, automated cell handling systems, and robot-based swift prototyping equipment to construct scaffolds [5].

Almost all forms of stem cells, including human embryonic stem cells (hESCs), induced pluripotent stem cells (iPSCs), and mesenchymal stem cells (MSCs) can be used in combination with AI. The target disorder of stem cell treatment might be automatically, precisely, and instantaneously detected. For quantitative research on hESC development, connections, and behaviors, video classification of the cells is essential [6]. In the meantime, due to its exceptional accuracy, the quantitative modeling of MSC culture and cell replication efficacy from micrographs, done with AI support, is a promising advancement [7]. Additionally, for iPSCs, ML can recognize and forecast iPSC creation by cellular reprogramming while enabling the prediction of iPSCs generation and differentiation from microscope slides [8].

The manufacturing of stem cells can be augmented through mechanization and automation. Several approaches can be employed in this situation, including the implementation of automated cell culture platforms (consisting of robotic and artificial intelligence algorithms) to enable massive cell production and improve technical precision, reproducibility, and productivity. These strategies also include the incorporation of contemporary imaging methods and analysis to boost the reproducibility of the cell culture protocols [9,10].

To improve stem cell delivery and performance, there are primarily two emerging AI applications. The first effect relates to the automation of simulation and model-building procedures using AI for increasing stem cell output. Second, the implementation of mathematical modeling can aid to identify the correlations between cellular traits and their microenvironments, thereby increasing tissue manufacturing performance while preserving cell therapy safety. When scientists used this technology to facilitate image evaluation and processing, they were also able to examine stem cells' morphology, distinguish between healthy and unhealthy cells, and identify the various functions of pluripotent stem cells. The fundamental premise is that an automated system can address observer bias because the currently accepted way to validate monoclonality is through manual examination using a microscope, which is operator-dependent, cost-ineffective, and demands a considerable amount of time and effort [11]. An example of this significance is related to the determination of the cell cultures quality created from human iPSC-derived cardiomyocytes in a prior research [12].

CONCLUSION

Stem cells and AI will make an excellent partnership for the healthcare system in the future. However, their integration requires careful consideration to avoid any negative consequences that could impede the growth of the healthcare sector.

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