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THERAPEUTIC APPLICATIONS OF STEM CELLS IN HEALTHCARE: CURRENT ADVANCES AND FUTURE PERSPECTIVES

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Abstract

Introduction: The aim of the study has been to inspect the current advancements and the future prospects of stem cell therapy. The benefits achieved from the utilization of the stem cell lines in numerous clinical directions have been recorded.

Literature Review: The application of the digital disruption theory has been fruitful for the accomplishment of the stem cell

therapy. The benefits and the disadvantages associated with the integration of therapy using stem cells have been identified in the section of the study.

Methodology: Collection of evidence from secondary sources for the conduction of theoretical inspection through thematic analysis has been performed in the study.

Findings: The inclusion of stem cell therapy has been achieved due to the pluripotent nature of the cells. Key themes based on the multi-potency of the cells and the development of regenerative medicines have been recorded in the study.

Discussion: Diminishment of the negatives of Crohn's disease, and Multiple Sclerosis, with the application of tissue engineering technology, has been achieved, with the usage of stem cells.

Conclusion: Hence, the study contained an overall inspection of the utilization of stem cell therapy in the advancing medical science. The future scope for further betterment of the technological advances for maintaining the stability and viability of the cell lines has been identified.

Keywords: Stem cells, clinical advancements, regenerative medicine, therapeutics, multi-potent cells

Introduction

Stem cells have been determined to be the undifferentiated biological cells that have the potential to transform into specialized groups of cells. Due to the presence of such a regenerative power, stem cells have been seen to be applied in the medical field, to replace or renew novel, normal cells without defects. Stem cells have been seen to be applied in cases of neurodegenerative diseases, treatments for cancer, and conditions such as Crohn's disease, baldness, and other such defects (Lovell-Badge et al. 2021). On the other hand, the pluripotent nature of these cells broadens the medical horizon toward the development of regenerative medicine and treats defective cells from their basic, nucleotide levels.

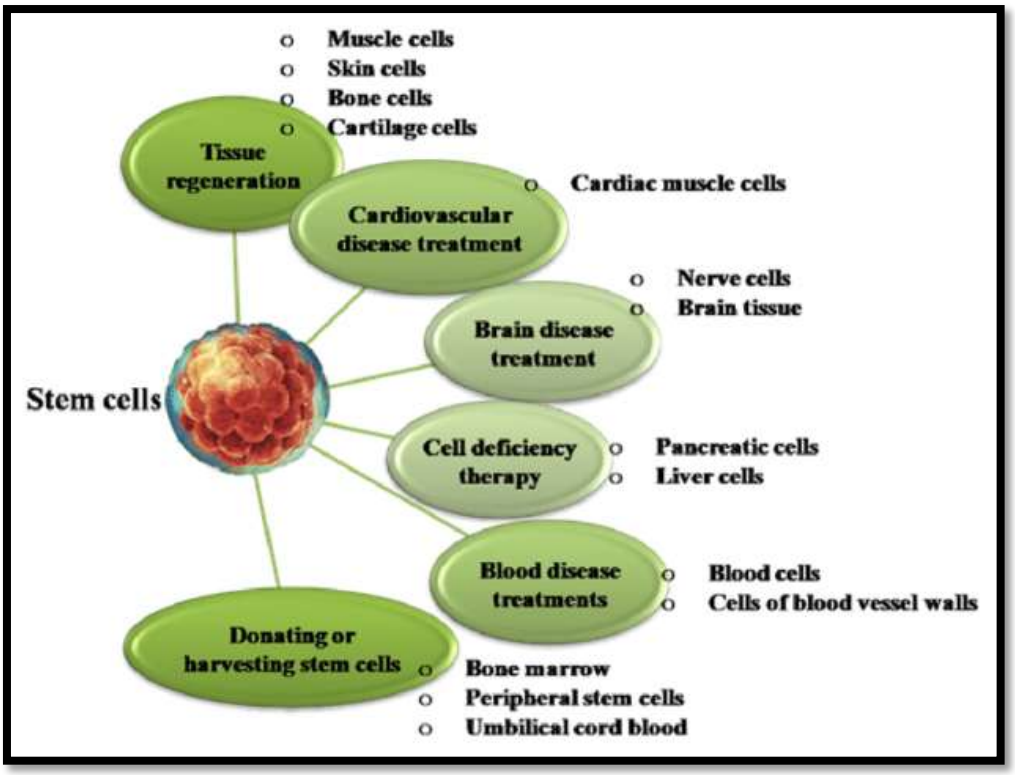

Figure 1: Variety of cells created through stem cells

(Source: Tasnim et al. 2020)

The examination of the various therapeutic applications of the stem cells proves to be widely beneficial for increasing the advancement in the medical field, and inculcating effective treatment for the patients (Kumar Gupta et al 2022). The identification of the different applications and their associated elements is highly requisite for the determination of the current conditions and the future directions to be taken in such a course.

Aim

The aim of the study is to examine the various therapeutic applications seen in the application of stem cells in the healthcare industry.

Research Objectives

The research objectives constructed for the study are mentioned below:

RO 1: To examine the elements of digital disruption increasing the availability of stem cells in the healthcare industry

RO 2: To inspect the benefits identified in the inclusion of stem cells in the healthcare domain

RO 3: To assess the issues for the integration of stem cells in the healthcare sector

RO 4: To analyse the future implications and advances toward the utilization of stem cells in the healthcare sector

Research Questions

The research questions constructed for the study are as follows:

RQ 1: What are the various fundamentals of digital innovation accumulating the availability of stem cells in the healthcare industry?

RQ 2: What are the advantages seen in the integration of stem cells in the healthcare field?

RQ 3: What are the certain concerns for the incorporation of stem cells in the healthcare sector?

RQ 4: What are the future inferences and improvements toward the utilization of stem cells in the healthcare sector?

Literature Review

Examination of the fundamentals of digital innovation in the rise of stem cell therapy

The inclusion of the theory of digital disruption has been extremely significant for seeing a rise in the utilization of the stem cells. According to the findings by Rodríguez-Fuentes et al. (2021), the application of such a theoretical framework has helped the medical facilities to recover the stem cells with the aid of a variety of medical devices such as low-speed centrifuge, and leukopheresis machines. On the other hand, as noted by Sunarti et al. (2021), without the expansion of the digital technologies, the advancements in such a direction would not have been made feasible. In addition to such, the viability of the cells and the maintenance of the stability such as cryo-tubes and similar others have been made possible with the development of technology in the manufacturing sectors of the healthcare industry.

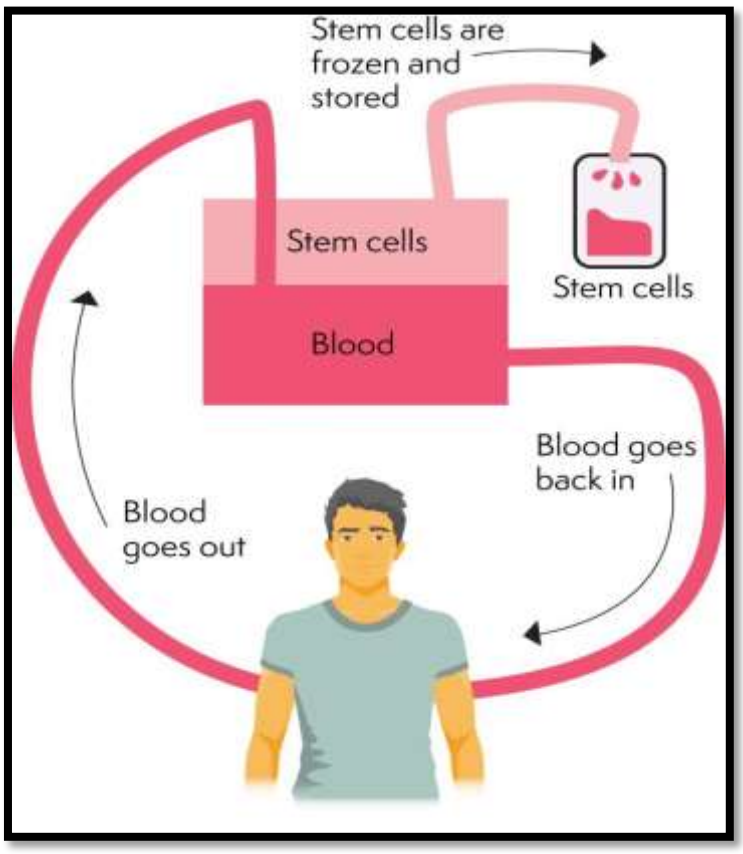

Figure 2: Leukopheresis machine and its process for stem cell recovery

(Source: Lymphoma-action.org.uk, 2023)

Therefore, the theoretical standpoint of digital disruption has been extremely significant for the improvement of the clinical advances in the stem cell therapy, and for the forthcoming aspects.

Analysis of the pros and cons related to the application of stem cell therapeutics

With the advancement of scientific processes in the medical field, the decrease in the mortality rates of the global population has been recorded. The betterment in the quality of life, and the maintained stability in the course of livelihood has been seen to occur through the development of the tools and technologies governing the medical sector. As per the comments of Rogers et al. (2020), one of the potential benefits of stem cell therapy is the abundance of the somatic cells, which can be availed from the donors. On the other hand, as noted by Banerjee et al. (2020), the issues related to the occurrence of histocompatibility between the donor and the recipient cells can be avoided. Hence, the incorporation of stem cells for the development of novel drugs, and the construction of regenerative can be performed.

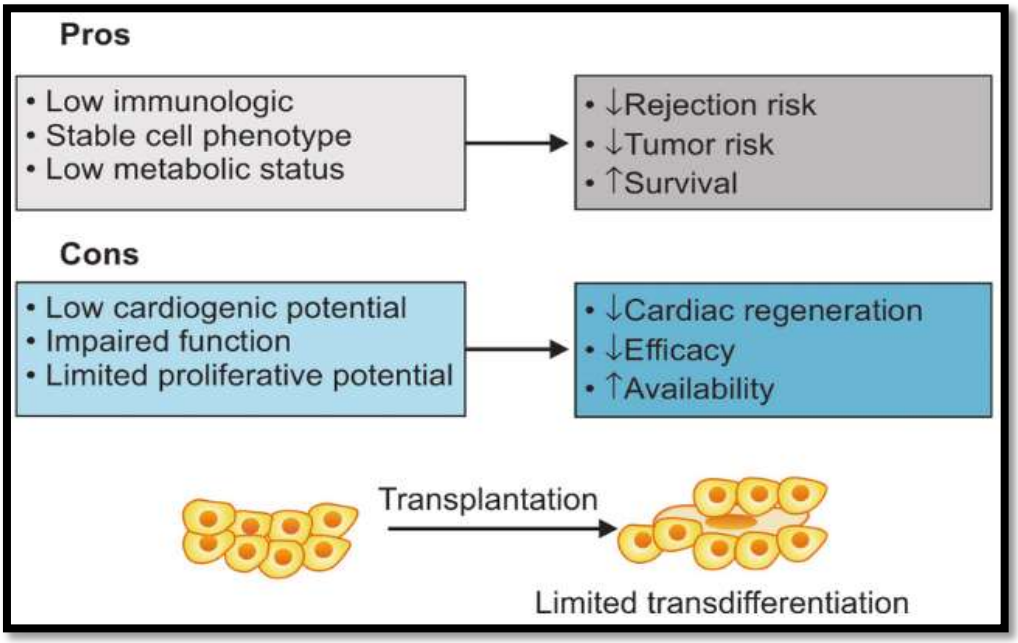

Figure 3: Pros and cons of stem cell therapy

(Source: Raik et al. 2020)

However, certain issues related to the utilization of the stem cells in the development of cell lines have been identified. As per the statements by Raik et al. (2020), the viability of stem cells tends to stay at about 85% minimum of 4 days at 4 degrees centigrade. With the extension in the time period, there is an overall decline in both the stability and the usage of such cells. On the other hand, as per the depictions by Jiang et al. (2021), there has been a lack of technological advancement which has the capacity of producing stem cells in an extensive number. Such an aspect reduces the overall potential of the researchers and scientists to maintain an elaborate study or assessment of the stem cells. Hence, such shortcomings are to be diminished to further improve the applicability of stem cells in the medical field.

Literature gap

In the past set of literature, the examination of the future improvements of stem cell therapeutics, with a linkage with digital disruption has not been performed in an extensive manner. According to the thoughts by Kosaric, Kiwanuka & Gurtner (2019), the determination of the digital elements for bringing about a betterment in the development of therapy with stem cells has not yet been constructed in a wide array. On the other hand, as per

the comments by Tasnim et al. (2020), the instruments for the recovery through the initiation of stem cell transplantation have not been inspected in an in-depth manner. Hence, the elements associated with digital innovation and their notions of stem cell betterment are to be assessed in an elaborate direction for availing the services in the future of healthcare facilities.

Methodology

The methodology of the research consists of the aligning steps and the procedures necessary for the collection and the interpretation of the data (Newman & Gough, 2020). The performance of the study has been based on the collection of evidence from secondary sources, through which the examination of the research concepts and variables has been achieved. Theoretical analysis of the key variables has been enabled with the integration of thematic examination, where focus has been laid on the development of the themes. These concepts have been constructed through the linkage between the impacting factors and the chief topic of examination, which has caused the study to contain an in-depth analysis of the aligning factors. Four vital themes based on the vital factors have been developed, increasing the overall potential of the domain of analysis, in the study.

Finding and Analysis

Theme 1: Inclusion of stem cell therapy for inducing haematopoiesis and halting neurodegeneration

Stem cells have been applied in the stream of developing a stronger immune system for halting processes linked with autoimmune diseases such as systemic Lupus Erythematosus, Sjogren Syndrome, Psoriasis, and others (Fayazi et al. 2021). The rapidly adapting antigens created with the help of hematopoietic stem cells of HSCs, alongside stromal cells, help in inducing haematopoiesis and creating novel blood cells. According to the opinions of Panegyres et al. (2023), the induction of haematopoiesis with erythropoietin in HSCs allows the regeneration of effective blood cells, diminishing the negative potential of the autoimmune diseases. In a similar manner, stem cells have been applied in the halting of neurodegenerative diseases and disorders such as Parkinson's and Alzheimer's diseases. As viewed by Mariottini, De Matteis & Muraro (2020), the neural stem cells have been noted to induce neurological protection with the aid of pharmacological stimulations. Thus, improvement in the recovery process has been enabled with the aid of stem cell therapy.

Theme 2: Issues in the application of stem cell therapy due to immunosuppression and tumor formation

One of the major shortcomings related to the growth of stem cells in the recipient body is the requirement for immunosuppression. As dictated by Yamanaka (2020), for the removal of infected or defective cells, the application of immunosuppression reduces the overall immunity of the recipient, which makes the individual susceptible to other diseases and disorders. On the other hand, in the thoughts and beliefs by Ford et al. (2020), the presence of pluripotency reduces the ability to acquire specific cell types, which overall diminishes the efficiency of the cells. Occurrences of tumor formation in embryonic stem cells have also been identified within the cells, due to the pleuripotent nature.

Theme 3: AI application in the stem cell research and achievement of greater cell efficiency

The application of Artificial Intelligence or AI has been acutely fruitful for the elaborating on the prospectus of gene editing. As per the opinions of Rogers et al. (2020), the notions of stem cell research with the help of AI for the inculcation of biomedical ethical principles have been instigated as consent and privacy are highly maintained. In the future direction of the research towards AI application in stem cell therapy, the adherence to the philosophies of equality of healthcare services for the various patients, can be modeled. As per the suggestions by Fuentes et al. (2021), this is due to the fact that the accountability for the usage of the stem cells for maintaining ethical governance can be enabled with the help of AI applications.

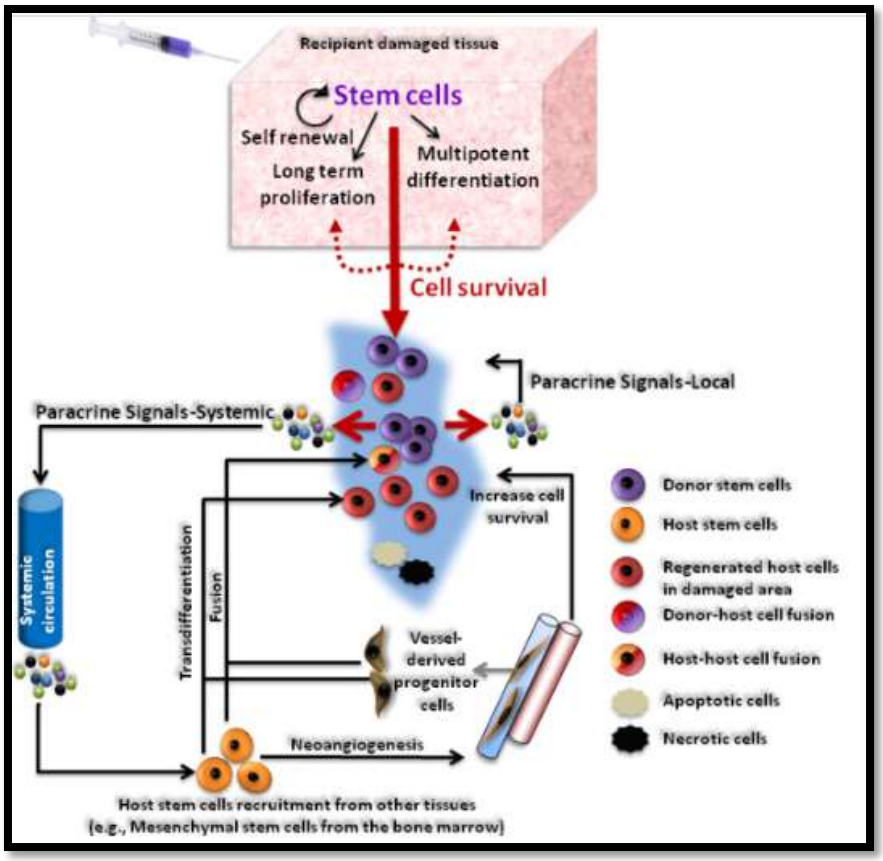

Figure 4: Mechanism of stem cell therapy

(Source: Rai et al. 2020)

Keeping a track of the administrative capacities can be considered with the utilization of AI measures (Sunarti et al. 2021). Hence, focusing on the collection and the maintenance of the stem cells for therapeutic purposes, alongside their administration can be governed by AI. Improvement of cell efficiency through the attribute analysis of the cells by AI and their editing measures can also be enabled with AI.

Theme 4: Tissue engineering technology in further investment of technological advancements in stem cell therapy

The inclusion of tissue engineering technology and gene editing has been important for the expansion of the domain of stem cells inspection, as the physiological availability of the cells can be induced for appropriate preferences. As per the notions by Tasnim et al. (2020), the ability of self-renewal capacity and the occurrence of the attribute of pluripotency have allowed the tissue engineering measures to establish stem cell isolation and the creation

of commercialized cell lines. On the other hand, the inclusion of molecular markers in the stem cells for the easier identification can be established, based on the tissue engineering technology.

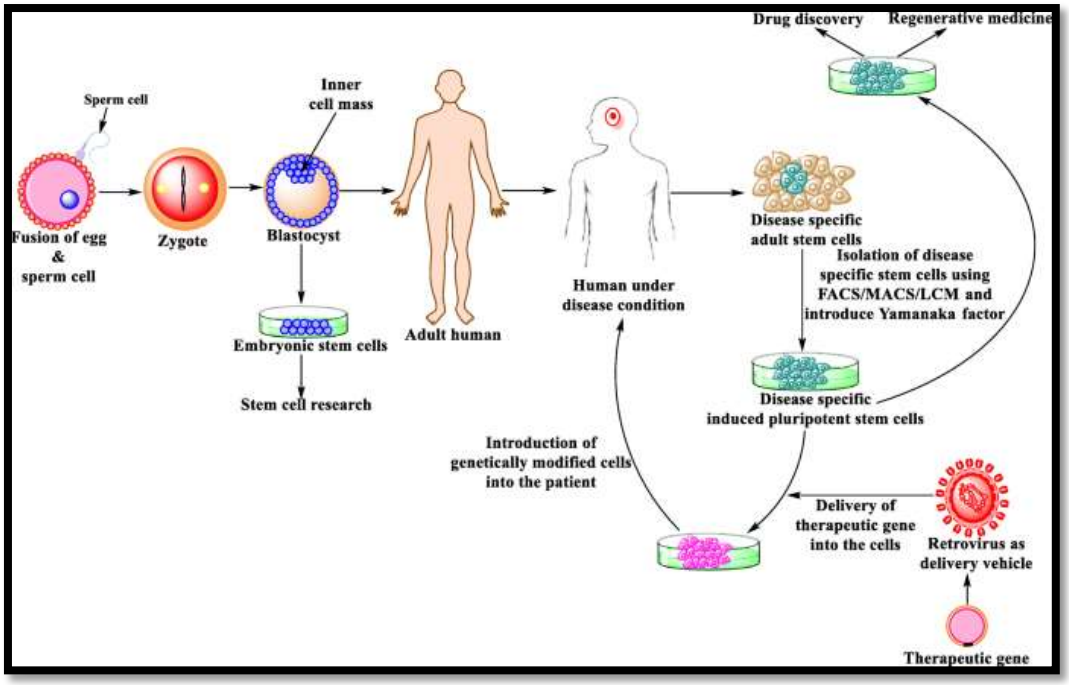

Figure 5: Tissue engineering technology in stem cell therapy

(Source: Rai et al. 2020)

As noted in the above figure, the induction of tissue engineering technology allows the development of therapeutic genes, to be integrated into the stem cells can be noted. Such an aspect would be gravely beneficial for the creation of drugs and regenerative medications.

Discussion

The application of stem cell therapy has been determined to be one of the most active directions in the medical field where the treatment of a wide range of diseases and injuries has been enabled. Such an aspect has been related to the pluripotent nature of the stem cells, the mitigation of the sentence related to diseases such as Crohn's disease, Multiple Sclerosis, and autoimmune diseases such as Lupus, has been achieved (Zhu et al. 2021). As depicted by Rufo et al. (2022), the trans-differentiation potential of the cells has allowed the generation of normal cell lines which are absent with the defective genes. In the current prospectus of stem cell therapy, the inculcation of regenerative medicine for repairing and replacing damaged tissues or cells has been noted. According to the suggestions of Devi et al. (2023), the distinctive characteristics which can be inculcated by the stem cells for replacing the damaged tissues have turned them to be a vital element in regenerative medicine. The differentiation of the cells into a wide variety of cell lines such as ectodermal, endodermal, and mesodermal origins helps these cells replace the dysfunctional layers. In addition to such, according to the comments by Mekelenkamp et al. (2021), the reparative mechanisms and the activation of self-regenerative properties of the stem cells allow the conduction of numerous experimental studies. Such aspects prove to be highly important for the medical community to see a growth in their grasp over the stem cell lines, and the demonstration of encouraging results can be achieved.

As noted in the findings, the inclusion of the prospectus of gene editing and biomedical technology has supported the increase of the potential of stem cell therapy. As stated by Chen et al. (2022), the notions of tissue engineering technology have been greatly beneficial for the creation of ex vivo remodeling of stem cells, which allow the alterations in the modular structure of the cells. On the other hand, according to the views of Atwa et al. (2022), the transformation of the cells into 3D organoids have helped the creation of personalized tissues for the patients, depending upon their places and requirement of applications. The multipotent stem cells have been seen to further aid the human body from rapidly adapting antigens, helping in the generation of immunity against autoimmune diseases. Hence, the application of stem cells for the overall rise in therapeutics and their efficiency has been noted.

Conclusion

Hence, the study examined the integration of stem cell therapy in the medical field, for the achievement of a greater efficiency of medicines and drug development. With the accomplishment of the digital innovation amidst the clinical facilities with the help of digital disruptive theory, novel directions for the usage of stem cells can be noted. In terms of the future direction of the research, the inspection of tissue engineering technology and gene editing for drug development and regenerative medicines can be noted. Such an aspect would be extremely useful for the treatment of neurological disorders and autoimmune diseases from the genetic level.

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