Short Communication

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New Technologies in Regenerative Medicine

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Abstract

The majority of articles related to regenerative therapeutics focus on new devices for various purposes like characterization of the unknown cells; the cell preparation and optimization for the isolation and culture for transplantation; the disease pathology and the medicines. It is prime important to secure patient's safety in recent advances in regenerative medicine and applications of new technologies to treat diseased or damaged organs and tissues by maintaining their normal function. This article is summarizing the facts of new technologies in regenerative medicine and obstacles during their application.

Keywords: Regenerative; Optimization; Genome; Transplant; Rejection.

Undeniably one of the most exciting fields in healthcare at present is regenerative therapeutics and is getting nearer and closer to changing the face of medicine. Evolving technologies such as gene therapy, tissue engineering and stem cells are the major elements of regenerative medicine which are gaining increasing attention of medical professionals. Successful clinical trial results driven by advances in addressing long-standing technical challenges are creating encouraging attention in this field. For example, several million-dollar partnerships to develop gene therapies for hemophilia, ophthalmic and some central nervous system disorders were signed by the top pharmaceutical companies over the last years.

Additionally, genome editing technologies like Clustered regularly-interspaced short palindromic repeats (CRISPR) and Zinc-finger nucleases have opened up new strategies for therapeutic intervention, leading to a wave of funding into emerging companies, which will explore some more technologies towards healthcare and explore some of the challenges and opportunities of cutting edge technologies in regenerative medicine and curative biologics.

Interesting new approaches in regenerative medicine and curative biologics have come into effect and efforts are continue towards perfection of treatment and safe cure from illness of patient. Some of these new processes include (i) Generation of autologous cartilage cells for transplantation (ii) Use of embryonic stem cells–derived oligodendrocyte progenitor cells to treat spinal cord injuries (iii) Enlisting of monoclonal antibodies (mAbs) to slow or reverse senescence (iv) Use of 3D bioprinting to create tissues for use in drug discovery and medical research (v) Use of cord blood stem cells in treating conditions such as injury, diabetes, CVS, CNS and some other diseases.

Regenerative medicine is a branch of translational research in tissue engineering and molecular biology which deals with the process of replacing, engineering or regenerating human cells, tissues or organs to restore or establish normal function of human body. Here damaged tissues and organs are engineered via stimulating the body's own repair mechanisms to functionally heal previously irreparable tissues or organs.

In regenerative medicine there are possibilities of growing tissues and organs in the laboratory and safely implanting them when the body cannot heal

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itself. The problems of organ transplant rejection and organ donation paucity will be potentially solved if cells, tissues and organs would be derived by the patient's own body [1]. In an article on hospital administration the term 'regenerative medicine' was used first time in 1992 with a series of short paragraphs on future technologies that will impact hospitals. Here it was stated that a new branch of medicine will develop as regenerative medicine to change the course of chronic disease and in many instances will regenerate tired and failing organ systems [2,3].

William Haseltine, the founder of Human Genome Sciences, commonly used the term regenerative medicine after he was briefed on the project to isolate human embryonic stem cells and embryonic germ cells. These newly-isolated cell lines opened the door for the first time in history in practical manufacture of all the cell types of the human body for the use in regenerative therapy. Regenerative medicine refers to a group of biomedical approaches to clinical therapies that may involve the use of stem cells [4]. Examples include the injection of stem cells or progenitor cells obtained through directed differentiation (cell therapies); the induction of regeneration by biologically active molecules administered alone or as a secretion by infused cells (immunomodulation therapy); and transplantation of in vitro grown organs and tissues (tissue engineering) [5,6].

Between year 1995 to 1998, Michael D. West tried first isolation of human embryonic stem cells and human embryonic germ cells. Dr. Stephen Badylak developed a process for scraping cells from the lining of a pig's bladder, decellularizing (removing cells to leave a clean extracellular structure) the tissue and then drying it to get a sheet or a powder. This extracellular matrix powder, nicknamed "pixie-dust," is being used to successfully regenerate tissue lost and damaged [7].

In June 2008, the first tissue engineered trachea / wind pipe transplantation was performed by Paolo Macchiarini and his team. Adult stem cells from the patient's bone marrow were extracted, proliferated and matured into cartilage cells or chondrocytes by an adaptive method devised for treating osteoarthritis. In 2009, the SENS Foundation was launched with aim 'the application of regenerative medicine to the diseases and disabilities of ageing" [8]. In 2012, Paolo Macchiarini and his team improved upon the 2008 implant by transplanting a laboratory-made trachea seeded with the patient's own cells [9]. On 12th September 2014, the surgeons of Institute of Biomedical Research and Innovation Hospital Kobe Japan, transplanted a 1.3x3.0mm sheet of retinal pigment epithelium cells, differentiated from iPS cells (induced pluripotent stem cells), into an eye of an elderly woman with age-related macular degeneration [10].

In January 2016, a paper published from the scientists of Bristol University has revealed a way to create any human cell type from another cell type directly, without the need for experimental trial and error. The pluripotent cells are the cells that have not yet decided what to become, so they have proposed the use of pluripotent stem cells to treat many different medical diseased conditions. The researchers have developed a computational algorithm called Mogrify, to predict the cellular factors for cell conversions [11].

Autologous or person's own cord blood stem cells can be safely infused back into that person without being rejected by the body's immune system and as they have unique characteristics compared to other sources of stem cells, they are in an increasing focus of regenerative medicine research. The use of cord blood stem cells in treating conditions such as brain injury and Type 1 Diabetes [12] is already being studied in humans, and earlier stage research is being conducted for the treatment of stroke [13,14] and hearing loss [15]. Researchers are exploring the use of cord blood stem cells under regenerative medicine applications like Type 1 diabetes [16], Cardiovascular (myocardial infarction, improve overall heart function), CNS (stroke, brain injury, alleviating mobility related symptoms, cerebral palsy) [17,18]. It seems that cord blood stem cells will likely be an important resource as medicine advances toward harnessing the body's own cells for treatment.

On 17th May, 2012, Osiris Therapeutics announced that Canadian health regulators approved Prochymal, the first stem cell drug to be approved anywhere in the world for a systemic disease. Graft-versus-host disease, a potentially fatal complication from bone marrow transplant, involves the newly implanted cells attacking the patient's body [19].

Some recent researches suggest that human iPS cells, once established, mostly exhibit a normal karyotype, are transcriptionally and epigenetically similar to ES cells and they maintain the potential to differentiate into derivatives of all three germ layers. Recent developments indicate optimism that safe, viral-free human iPS cells can be derived routinely in the near future. An important next step will be to identify ways of assessing which iPS cell lines are sufficiently reprogrammed and safe to use for therapeutic applications. The approach of generating patient-specific pluripotent cells will undoubtedly transform regenerative medicine in many ways. Patient-derived pluripotent stem cells hold great promise for tissue and organ engineering, when

robust and mature cells can be directed in a reliable and safe manner. Recent advances in bioengineering organs raise the hope that we can overcome organ donor shortage and eliminate the need for livelong immunosuppression. However, significant challenges remain in generating mature large-scale donor-like bioartificial organs [20].

Endogenous regenerative technology (Endoret) involves the use of patient's own biologically active proteins, growth factors and biomaterial scaffolds for therapeutic purposes. This technology provides a new approach for the stimulation and acceleration of tissue healing and bone regeneration. The versatility and biocompatibility of using patient-derived fibrin scaffold as an autologous, biocompatible and biodegradable drug delivery system open the door to a personalized medicine that is currently being used in numerous medical and scientific fields including dentistry, oral implantology, orthopedics, ulcer treatment, sports medicine and tissue engineering among others [21].

In new technologies in regenerative medicine, it is prime important to secure patient's safety. Latest studies remove the suspicion and show that the act of creating pluripotent stem cells for clinical use is unlikely to pass on cancer-causing mutations to patients.

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