Changing Paradigms in Healthcare Medicine

Pradeep V. Mahajan[1*], Anurag P. Bandre[1], Neetin S. Desai[1]

1. Chairman and Managing Director, StemRx Bioscience Solutions Pvt. Ltd., R-831,T.T.C., Thane Belapur Road, Rabale, Navi Mumbai, Maharashtra, India

**Corresponding Author and Address: Dr. Pradeep V. Mahajan, StemRx Bioscience Solutions Pvt. Ltd., R-831,T.T.C., Thane Belapur Road, Rabale, Navi Mumbai, Maharashtra, India Email: drpvmahajan@gmail.com*

Abstract

The science of healthcare medicine is changing rapidly and coming out of its shell with better prospects. The healthcare sector is now not limited to the old concept of one pathogen causing one disease and treated by one medicine but it is being replaced by the application of newer treatment modalities to treat the diseases and disorders. The concept of donor organ transplant is now changed to concept of organ regeneration (using IPSC's- induced pluripotent stem cells or even using autologous stem cells). Regenerative Medicine has played a big role in this paradigm shift. The Regenerative medicine - a branch of translational research uses stem cells in tissue engineering and molecular biology which deals with the process of reengineering or regenerating human cells, tissues or organs at the defective sites to restore or establish normal function. The applications of Regenerative Medicine are worldwide and it is now important to enhance the efficacy of these applications by merging the distinguishing fields of science using the variables those can change the paradigms of Regenerative Medicine.

Keywords: *Regenerative Medicine, Stem cells, IPSC's, organ regeneration*

Introduction

Stem cells are not new to us and we all know the importance of therapeutic applications of the stem cells in different disease and disorders but we are also aware about the fact that stem cell therapy has sparked much controversy over the last several years as this field is still surrounded by ethical, legal, political and social barriers. Safety and efficacy issues in use of stem cells have raised the concern about their use in the treatment of different diseases and disorders but if these issues are properly taken care of Stem Cells can play the role of wonder drug in modern medicine. Most of the medical experts are aware about the fact that old and conventional medical therapies have proven to be ineffective and useless for many of the dreadful diseases. In such cases where people are asked to compromise with their health condition, stem cells can really prove a medicinal boon to such patients. The Regenerative Medicine market has already started encroaching European and US countries with stem cells products, therapies and technologies. There is no doubt that the upcoming era will be of Cellular medicine with more and more treatment modalities. As shown in the Fig.1, it is clear that how fast this parallel science of Regenerative medicine is showing its potential in the global healthcare market. What requires now is to understand its wide scope and to focus on the usefulness of this science in the mass.

Regenerative medicine based on the applications of the stem cells comprises a market for regenerative products and can be seen growing exponentially in coming years. Stem cells have wide use in treatments of orthopedic conditions, neurodegenerative conditions, cardiovascular diseases and even in several chronic metabolic disorders. Other disorders that will benefit from cell therapies include diabetes, inflammatory diseases, and several aging disorders. The success ratios may vary with respect to disease condition and the type of therapy used. Many a times it is seen that efficacy of the treatment is dependent on the allied treatment modalities coupled with the main stem cells therapy.

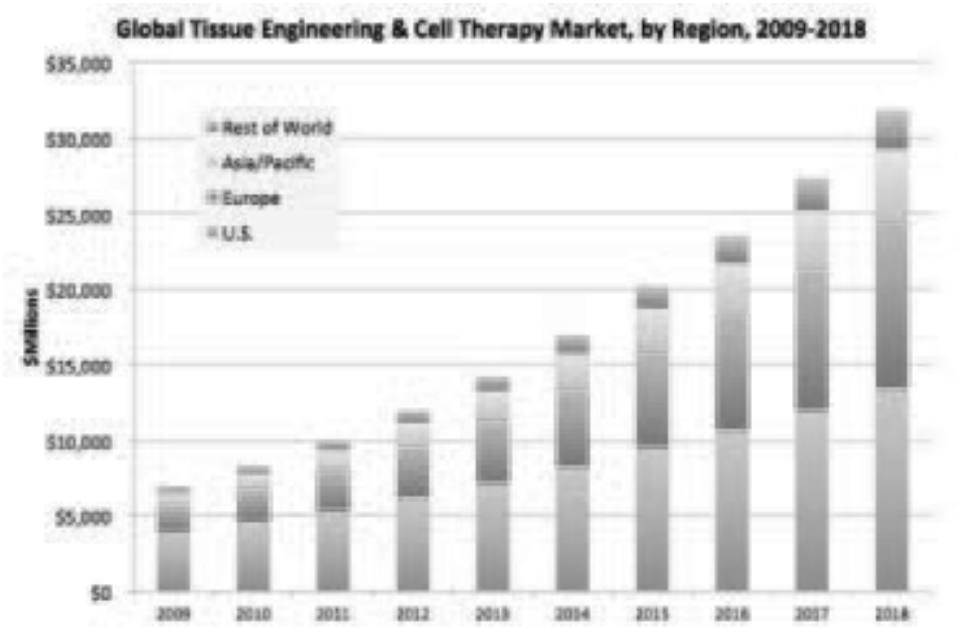

Fig 1. (Source: Report #S520, "Tissue Engineering, Cell Therapy and Transplantation: Products, Technologies & Market Opportunities, Worldwide, 2009-2018.")

These variables may play an important role in deciding the fate of stem cells therapy in curing the signs and symptoms of disorders.

The variables of changing paradigms for regenerative medicine

The distinguishing fields of allied treatment modalities which can really revamp the Regenerative medicine comprise of game changing technologies like Robotic medicine, Tele medicine, Digital medicine, Genomic & molecular medicine and nanomedicine.

Stem Cells and Robotic Medicine

Stem cells are the repairing kits which we carry in our body. There are many sources of stem cells like cord blood, cord tissue, bone marrow, adipose tissue which can be used for the therapeutic applications. In autologous cellular treatment patients own body cells are transplanted back after processing them in vitro. Robotic Medicine is not new to healthcare. We all are aware about the Vinci Surgical system that arose in 2000. Robotic system has eased the complex surgeries and is based on the high end mechanics. In regenerative medicine stem cells harvesting procedures and transplant procedures can definitely be coupled with the use of robotic arms and set the new perfections. Recently in 2014 Bolinger M, Wechsler L and Stein J in their studies have concluded that robotics, stem cells, and brain-computer interfaces all have tremendous potential to reduce disability and lead to better outcomes for patients with stroke (1). However continued research and funds will be required to strengthen these fields as merging capacities of these sciences are still in a nutshell.

Stem Cells and Telemedicine or Digital medicine

The wireless innovations in healthcare have revolutionized the concept of remote consultations. Using high end technologies and advanced ways of communication, now it's possible to transfer the medical information through audiovisual media. With the use of Google mirror, holographic consultations are possible indoors, sitting at home. Virtual medical visits and holographic consultations have made communication easy and will be the milestone for creating awareness about the importance of regenerative medicine in mass. The cost effective and time saving parameters further add to the importance in this area. Digital medicine is a multidisciplinary subject that arose with the merging of medicine and new digital technologies, and covers subjects such as

medicine, mathematics, informatics, electronics and mechanical engineering. It can be used for basic research, clinical studies, and for treatment of various diseases (2). Zhu Weijun et al in 2014 have shown the importance of Telemedicine and digital management in repair and regeneration after nerve injuries and other nervous system diseases (3).

Stem Cells and nanomedicine

Nanotechnology allows scientists to create, explore and manipulate nonmaterial measured in nanometers which can be used in advanced surgeries. The Clinical Potential of Targeted Nanomedicine delivering to Cancer Stem-like Cells is now world known as Sang-Soo Kim et al have shown the importance of nanomedicine treatments on cancer patients for the delivery of stem cells. They developed a tumor-targeting nanodelivery platform (scL) for systemic administration of molecular medicines. In various animal models, Post treatment with the scL nano-complex carrying various payloads, they observed exquisite tumor-targeting specificity and significant antitumor response with long-term survival benefit (4).

Stem Cells and Bioengineering

Regenerative medicine also includes use of biodegradable scaffolds with stem cells and their safe implantation at the defective sites. Combining stem cells with biomaterial scaffolds provides a promising strategy for engineering tissues and cellular delivery. Biomaterials can be natural or synthetic, protein based or polysaccharide based. Protein based natural biomaterials are collagen, silk and fibrin while Polysaccharide based natural biomaterials are agarose, alginate, hyaluronan and chitosan. Synthetic biomaterials include PLGA Poly (lactic-co-glycolic acid) and PEG (Poly ethylene glycol). The type of the biomaterial or the cues used, play an important role in deciding the fate of the stem cells implanted. Stem cells along with these biomaterials have been used in many treatment modalities for orthopedic conditions like cartilage repair, bone fractures, tendon injuries and many more. Besides orthopedic conditions, stem cells with scaffolds have proven their efficiency in cosmetics and even in cardiac operations. Cell sheets of MSC's (mesenchymal stem cells) have seen to improve cardiac function when used with collagen (5).

Organ Development with 3D printing technology

Tissue engineering technology promises to solve the organ transplantation crisis. The assembly of vascularized 3D soft organs remains a big challenge. Organ printing defined as the computer aided, jet based 3D tissue-engineering of living human organs offers a possible solution. Organ printing involves development of blueprints for organs followed by actual organ printing and organ conditioning. Cell printers that can print gels, single cells and cell aggregates have been developed. Solidified thin layers of sequentially placed, thermo-reversible gel serves as printing paper. Combination of engineering approach with embryonic tissue fluidity concept of developmental biology enables the creation of a new rapid prototyping 3D organ printing technology, which has the potential to accelerate and optimize the tissue and organ assembly dramatically (6). 3D printing technologies are already being used in pharmaceutical research and fabrication, and look promising in bringing transformation. Advantages of 3D printing include high reproducibility, precise control of droplet size and dose, and the ability to produce dosage forms with complex drug-release profiles.

Complex drug manufacturing processes can also be standardized through use of 3D printing to make them simpler and more viable. 3D printing technology could also prove beneficial in development of personalized medicine (7).

Revamping of Healthcare Sector

Regenerative medicine coupled with all the above mentioned advancements and can revamp the entire healthcare sector. During this happening the paradigm of healthcare has shifted towards cellular medicine from the old conventional medicine. In the due course of time surgeons have done number of successful transplants with the help of stem cells. For an instance, Hip replacement is taken over by hip regeneration and Instead of spending millions of dollars on insulin injections, now it is possible to regenerate insulin factories in vivo to eliminate diabetes completely (8). Similarly in several orthopedic conditions,

neurodegenerative and neuro developmental conditions stem cells treatments have proven their existence. In the coming years researchers may introduce the stem cells gene therapy for immunomodulatory treatments in autoimmune disorders. Ground breaking invention of T cells educator therapy for autoimmune disorders by Dr. Yong Zhao (9) as highlighted by the American Diabetes Association at 72nd Scientific Sessions (Philadelphia, 2012) is one of the 8 major breakthroughs and initiatives which were done in 2012. Stem cell growth and migration on nano-fibrous scaffolds and micro-fluidic channels on Silicon-Chip were studied using neural stem cells isolated from adult rats. Possibly this technology of using neural stem cells will revolutionize the treatment protocols in electrical signal neural transmission system (10). The invention of VSEL's (Very small embryo like stem cells) or DC dendritic cells have already raised the standards of treatment modalities in cancer medicine (11).

Discussion

Science is so evolved that concept of developing a body organ which looked like a dream once upon a time is no more fiction but has turned into reality with the help of 3D printing and scanner technology. Now it is possible to develop organs like liver, kidney etc. This clearly indicates that Regenerative medicine is the future of the medicine and conceptually the day is no far when one can access the organ shops easily in healthcare market. However this field is under siege politically and financially so it needs an urgent attention to promote this science which has true powers of revamping the complete healthcare sector. Medical technology is growing rapidly. Several diseases can now be treated very effectively with the application of implantable devices that restores physical and mechanical function, such as replacement of hip joints or restoration of heart rhythms by pacemakers. The techniques however, are rather limited, and biological function cannot be restored through the use of inert materials and devices. Patients today demand quality health care and Health care practitioners demand stability which has to be taken care of otherwise it will lead to the problem of health crisis. This may lead to legislation expanding the scope of practice for allied health care providers, thereby circumventing physicians and undermining our control. If we really want to avoid the health crisis problem, revamping of healthcare medicine is necessary and globally it requires an urgent attention to step towards the better healthcare system.

References

1. Boninger ML, Wechsler LR, Stein J. Robotics, stem cells, and brain-computer interfaces in rehabilitation and recovery from stroke: updates and advances. Am J Phys Med Rehabil 2014 ; 93 (11 Suppl 3):S145-54.
2. Wang LS, Luo YH. Digital medicine and digital orthopedics: a hot topic in tissue engineering. Zhongguo Zuzhi Gongcheng Yanjiu Yu Lichuang Kangfu. 2008; 12:6374-6380.
3. Zhu W, Zhai Y, Sun D, and Zhao J. Telemedicine and digital management in repair and regeneration after nerve injury and in nervous system diseases. Neural Regen Res. 2014; 9(16): 1567-1568.
4. Kim S, Rait A, Rubab F, Rao AK, Kiritsy MC, Pirollo KF, Wang S, Weiner LM and Chang EHThe clinical Potential of Targeted Nanomedicine:Delivering to cancer Stem-like cells. Molecular Therapy 2014; 22(2):278-291.
5. Miyahara Y, Nagaya N, Kataoka M, Yanagawa B, Tanaka K, Hao H, Ishino K, Ishida H, Shimizu T, Kangawa K, Sano S, Okano T, Kitamura S, Mori HMonolayered mesenchymal stem cells repair scarred myocardium after myocardial infarction. Nat Med 2006; 12:459 - 465.
6. Murphy SV and Atala A. 3D bioprinting of tissues and organs .Nature Biotechnology. 2014; 32, 773-785.
7. Ursan I, Chiu L, Pierce A. Three-dimensional drug printing: a structured review. J Am Pharm Assoc. 2013;53(2):136-144
8. Pagliuca FW, Millman JR, Gurtler M, Segel M, Dervort AV, Ryu JH,Peterson QP, Greiner D and Melton DA. Generation of Functional Human Pancreatic β Cells In Vitro. Cell. 2014;159(2):428-39
9. Yong Zhao. Stem Cell Educator Therapy and Induction of Immune Balance. Curr Diab Rep. 2012;12(5):517-23.
10. Geng Z, Du J, Zhang L , Yang C , Wang W and Li Z.(2010).Separation And Enrichment Of Mesenchymal Stem Cells On A Chip. In 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences ; Groningen, The Netherlands
11. Nagaraj S, Ziske C and Schmidt IGH. Dendritic cell, the immunotherapeutic cell for cancer .Indian J Med Res 2004;119, 133-138