Archives of Health Science
Short Reports

Then and Now: Regenerative Medicine — A Short Over view

[1,2,3,4] **Prof. Dr. Willie Sai Ho Chan, LLB, MD***

[1]Queen's College, Hong Kong, China

[2]The China Medical University, Taichung, Taiwan, China.

[3]The China University of Political Science & Law, Beijing, China.

[4]The National Representative of European Association for Predictive, Preventive & Personalised Medicine (EPMA) in Taiwan, China.

Website:-

http://www.epmanet.eu

http://www.epmanet.eu (Taiwan)

***Corresponding author:** Prof. Dr. Willie Sai Ho Chan, LLB, MD, The China Medical University, Taichung, Taiwan, China. Email: chan@epmanet.eu.

Abstract

This is an article on regenerative medicine about the current status and prospects of the field. Regenerative medicine is a branch of translational research which deals with the process of replacing, regenerating or engineering human cells, tissues, or organs to restore or establish normal function (1)

Stem cells are cells with the ability to grow and differentiate into more than 200 cell types. The differentiation ability of all stem cell types would be stimulated to obtain specialized cells that represent renewable sources of functional cells useful for cell-based therapy.

Keywords: Stem cells; genetic; Artificial Intelligence; transplantation; microgravity; prescriptions; algorithm; degenerative disease; tissue engineering

Introduction

Regenerative medicine is an interdisciplinary research field focused on restoring damaged tissue by engineering products that support the body's own repair mechanisms. The purpose of medicine is to maintain the immortality of life. For a long time, the hope of immortality is the common dream of mankind. The concept and scope of regenerative medicine is very broad. In a broad sense, regenerative medicine can be considered as an emerging discipline to study how to promote the physiological repair of trauma and tissue and organ defects, and how to carry out tissue regeneration and functional reconstruction. Also study the normal tissue characterustics and functions of the body, the mechanism of wound repair and regeneration, and the mechanism of stem cell differentiation, and find effective biological treatment methods. More than that, promote the body's self-repair and regeneration, or build new tissues and organs to maintain, repair, regenerate or improve damaged tissue and organ function. In a narrow sense, it refers to the use of principles and methods of life sciences, materials science, computer science and engineering to research and develop definitions and information technologies for replacing, repairing, improving or regenerating various tissues and organs of the human body.

Stem cells start off as unspecislised cells but given the right chemical and genetic signals can divide to form more specialised cells of different size, shape and functions, eventually giving rise to highly specialised cells. Stem cells are a population of undifferentiated cells characterized by the ability to extensively proliferate (self-renewal), usually arise from a simple cell (clonal), and differentiate into different types of cells and tissue (potent) stem cells can be used in cellular therapy to replace damaged cells or to regenerate organs. Stem cell therapy holds great promise for treating and perhaps one day curing many disease.

The regenerative capacity of endogenous stem cells decreases with age, is impaired in degenerative diseases, and deregulated in cancer. Our ability to maintain and restore normal tissue function therefore requires that we understand not only the identity, properties and function of normal stem cell, but also the processes that alter their function during ageing, and in both malignant and degenerative diseases.

For those who are already suffering from a disease that stem cells can treat, storing stem cells may have a personal importance and relevance. For others, it is likely that at some point in their life, they or a loved one will be affected by a disease that stem cells can treat. The first successful stem cell transplant using stem cells found in the umbilical cord blood was in 1988. The patient was a little boy suffering from a serious blood disorder called Fancom's Naemia, and the cord blood was obtained from his new born sister.

The most important objective of regenerative medicine is to take into account the patient specific disease characteristics which will largely affect the outcome of the treatment provided. Artificial Intelligence can be employed to understand and map these characteristics by combing it with robotics and automation and also compare and contrast the results of the mapping with previously existing clinical records. This gives the opportunity to accurately understand the similarities and differences between the patient's condition and other similar cases attempted to be treated before. Programs are written to identify biomarkers and understand their functions and roles. The learning algorithm collects and combines information from the data set that is provided. This means that as the clinical uploaded into the system increases, the algorithm becomes more precise and accurate in devising solutions based on the larger data set to draw calculated conclusions from.

There has been an increase in the use of mathematicsl models constructed to predict the outcomes of hypothetical treatments scenarios. This combined with the learning algorithm will offer wholesome information that includes diagnostics and specificity of the patient's case with currently existing treatments, insights into the mechanism underlying the probability of success or regarding the relevant functions of genes involved in the disease while running programs that will provide data about the most feasible treatment to consider along with a success percentage. Mathematical models based on neural networks can be used for complex tissue engineering and the prediction of tissue engineering results. Additionally, robot based rapid prototyping system for scaffold fabrication and automated cell processing robotic systems can be established.

Stem cell research is one of the most exciting and fast-paced areas of biological research and development in the world today. Our human body is made up of 200 different types of cells. Each type cell, such as muscle cells, skin cells and nerve cells, etc., specialises in performing a certain function. Stem cells are primitive cells that have not yet differentiated into specialised cells. Their role is to replaced specialised cells that have been lost through injury, disease, or normal course of events (such as regeneration of the lining of our bowel every few days).

MSCs were known as somatic stem cells, which are capable of self-renewal and retain the potential to differentiate into multiple lineages. MSC therapy is likely to be effective for the treatment of various diseases such as osteoarthritis, cerebral infarction, spinal cord injury, chronic kidney disease, and cirrhosis, in addition to other degenerative and inflammatory diseases.(2)

Developments in regenerative medicine are making it possible for patients or athletes to live without debilitating heart disease, to regrow cartilage in an injured knee, for injured soldiers to recover and return to normal life, for children with congenital heart defects to receive a heart or valve patch that will grow as they do, and for researchers to finally understand the initiation and progression of various diseases of organs and other connective tissues. But the potential for stem cell medical therapies often seems to be matched only by the controversy the phrase sometimes inspires. Previously, there was a paper published in Nature, though, may point to a way to regress adult cells back into stem cells --- by putting them under environmental stress such as slightly acidity or physical pressure. While the study used mice cells, the medical impact of making stem cells on a larger scale while avoiding the debate surrounding embryonic stem cells could be staggering. Locally, researchers at NIH, Washington University, Johns Hopkins University and other research institutes are exploring all kinds of ways to use stem cells to improve people's lives. Unlike drugs, stem cell therapy may be a personalised treatment and the stem cells may not be produced and tested for quality in large batches. According to international standards, a new medical treatment should first be treated in the laboratory and in animal studies before they can be used in clinical trials for consented volunteers. When the treatment is proved to be safe and effective, it can be put to general uses.

Perhaps most important, stem cells and the future of regenerative medicine also provides an overview of the moral and ethical problems that arise from the use of embryonic stem cells.

Although a number of ethical issues have arisen in stem cell research (3), recent advances in stem cell isolation and development have helped scientists to identify and culture specific cell types for regeneration of tissue in various disorders such as Parkinson's (4), Alzheimer's (5), or diseases of the heart (6), muscles (7), lung (8,9), liver (10), and other organs. (11)

A concern with illness has been documented in China for three millennia, the earliest written evidence extant today on theoretical and practical consequences of this concern dates from approximately the eleventh century B.C. At that time, and for centuries to come, it was assumed that the well-being of the living --- be it related to success on the battlefield, to an abundant harvest, or to physical health --- depended to a considerable extent on their interactions with the non-living members of the community (i.e., with their ancestors). An adherence to specific norms was thought to guarantee social and individual health; transgressions were known to cause the wrath of the dead, who then had to be propitiated with sacrifices. The communication between the living and the non-living that was necessary to establish the cause of an affliction and identify an appropriate remedy was recorded on bones and turtle shells, many of which were found in the soil, especially in the province of Henan, earlier this century. Whether the mom belief in ancestral intervention was supplemented by a pragmatic application of drugs or other empirically valuable means of therapy was not documented in written form at this early time.

Ancestral and gemological notions of health and illness are mentioned here for two reasons. First, they have survived in Chinese culture until the present time aspects of the overall system of conceptualized and practical healthcare, particularly in the treatment of mental and children's illnesses. Second, Chinese medicine, documented since the second century B.C. and developed as a system of ideas and practices based on insights into the laws of nature rather than on metaphysics, still embodies some of the fundamental tenets of these earlier approaches to understanding health and healing, namely an emphasis on cause-effect relationships and a localistic-ontological notion of disease.

Pharmaceutical knowledge was recorded with astonishing sophistication in a collection of prescriptions found among the Ma-wang-tui scripts named Wu-shih-erh ping fang (Prescriptions against 52 ailments) by modern researchers. At about the time of the compilation of the Nan-ching (and coinciding with the appearance of the materia medical of Dioscorides in A.D. 65 in the West), Chinese pharmaceutical knowledge found its own literary form when the first Chinese herbal was compiled, which became known by the title Shen-nung pen-ts'ao ching (The divine husbandman's classic on materia medica).

The Ma-wang-tui manuscripts, the Huang-ti nei-ching, the Nan-ching, and the Shen-nung pen-ts'ao ching are the main sources for our current understanding of the early developmental phase of Chinese medicine, even though the last three may have undergone considerable revisions in later centuries and cannot be considered genuine Han dynasty sources in their entirety. Still, the picture emerging from studies of these sources so far reveals the formation of several complex and multifaceted approaches to healthcare, all of which were associated with basic social, economic, and ideological changes preceding and following the unification of the Chinese Empire in 221 B.C.

Chinese medicine emphasized an ontological perspective and was quite familiar with localistic notions of illness, only a few dissections were recorded during the imperial age, and surgery was never developed much beyond the knowledge needed for performing castrations.

Cataract surgery was introduced from India as early as the Tang dynasty, but was never really integrated into Chinese medicine or further developed, despite the great number of patients who could have benefited from such operations. The reasons for such reluctance to explore human anatomy and develop surgery are unclear, also unclear is the reason for the failure to expand certain knowledge that reached an impressive stage at some time but went no further. An example is the world's first treatise on forensic medicine, the Hsi yuan lu (The washing away of wrongs) of 1247 by Sung Tz'u.

The late 1990s were marked by two high-profile discoveries in the field of developmental biology that heralded a resurgence of interest and belief in the field: Dolly the sheep was cloned in Roslin, Scotland (12) and the first human embryonic stem cells were simultaneously isolated in Wisconsin, USA (13) and Johns Hopkins.

The major obstacles faced in regenerative medicine is achieving precision in engineering the tissue or sheet of cells required for the transplantation. There are very few scientists in the world who can achieve the level of accuracy needed while culturing the cells and making transplants. This naturally curbs the outreach of the treatment process due to lack of expertise among a larger group of individuals. Training individuals in this area to become experts is a cost heavy and time intensive process. Artificial Intelligence along with robotics is the ideal solution. The robotics will help in producing identical and contamination free cell cultures and transplants based on the information obtained from the algorithms.

Findings from space-based science on stem cells could aid in the development of cellular therapies, tissue engineering, and other areas of regenerative medicine. MacArthur and Oreffo defined tissue engineineering as “understanding the principles of tissue growth, and applying this to produce functional replacement tissue for clinical use."(14)

For instance, exploiting the unique behavior of stem cells in microgravity could improve cell-based therapies for a variety of diseases and impairments, such as traumatic brain injury and type 1diabetes. Similarly, microgravity could allow 3 D printers to create complex tissue structures that are difficult to achieve in the presence of full gravity. We can use the space station as a test bed for regenerative medicine advances and product development in low Earth orbit.

Conclusion

Regenerative medicine is the future technology that aims to heal or restore human tissues and organs damaged by age, disease, or trauma, back to the original condition. It is a multidisciplinary field, and to increase the likelihood of success, it is incumbent on those involved to draw on the expertise of a wide range of fields and stakeholders. It is not just a future hope, it is a reality today.

Acknowledgments

First and foremost, I am deeply grateful to my parents, Mr Chan Sum and Mrs Lon Siu Ying, for their wise counsel and sympathetic ear. You are always there for me. To all my team members, I say thank you for your friendship and courtesies. I think the most important thing is to work

from our heart and to honour all those I encounter in my work with love and support.

References

[1] Encyclopedia of Biomedical Engineering, 2019

[2] Fumiko Yano, Taiga Takeda, Takafumi Kurokawa, Toskiya Tsubaki : Effects of conditioned medium obtained from human adipose-derived stem cells on skin inflammation. Regenerative Therapy 20 (2022) 72-77. JRSM. journal homepage: http://www.elsevier.com/locate/reth

[3] McCormick JB, Huso HA: Stem Cells and ethics: current issues. J Cardiovasc Transl Res 2010; 3:122-127.

[4] Xi J, Zhang SC: Stem cells in development of therapeutics for Parkinson's disease: a perspective. J Cell Biochem 2008; 105: 1153-1160.

[5] Magga J, Savchenko E, Malm T, Rolova T, Pollari E, Valonen P, Lehtonen S, Jantunen E, Aarnio J, Lehenkari P, Koistinaho M, Muona A, Koistinaho J: Production of monocyte cells from bone marrow stem cells: therapeutic usage in Alzheimer's disease. J Cell MOI Med

[6] Perin EC, Silva GV, Zheng Y,. Gahremanpour A, Canales J, Patel D, Fernandes MR, Keller LH, Quan X, Coulter SA, Moore WH, Herlihy JP, Willerson JT: Randomized, double-blind pilot study of transendocardial injection of autologous aldehyde dehydrogenase-bright stem cells in patients with ischemic heart failure. Am Heart J2012;163: 415-421,421.e1.

[7] Cerletti M, Jurga S, Witczak CA, Hirshman MF, Shadrach JL, Goodyear LJ, Wagers AJ: Highly efficient, functional engraftment of skeletal muscle stem cells in dystropic muscles. Cell 2008; 134:37-47

[8] Tzouvelekis A, Koliakos G, Ntolios P, Baira I, Bouros E, Oikonomou A, Zissimopoulos A, Kolios G, Kakagia D, Paspaliaris V, Kotsianidis I, Froudarakis M, Bouros D: Stell cell therapy for idiopathic pulmonary fibrosis: a protocol proposal. J Transl Med 2011; 9:182.

[9] Weiss DJ, Bertoncello I, Borok Z, Kim C, Panoskaltsis-Mortari A, Reynolds S, Rojas M, Stripp B, Warburton D, Prockop DJ: Stem cells and cell therapies in lung biology and lung disease. Proc Am Thorac Soc 2011; 8: 223-272.

[10] Rashid ST, Corbineau S, Hannan N, Marciniak SJ, Miranda E, Alexander G, Huang-Doran I, Griffin J, Ahrlund-Richter L, Skepper J, Semple R, Weber A, Lomas DA, Vallier L: Modeling inherited metabolic disorders of the liver using human induced pluripotent stem cells. J Clin Invest 2010; 120: 3127-3136.

[11] Lodi D, Lannitti T, Palmieri B: Stem cells in clinical practice: applications and warnings. J Exp Clin Cancer Res 2011; 30: 9.

[12] Wilmut I, Schnicke AE, MeWhir J, Kind AJ, Compbell KH: Viable offspring derived from fetal and adult mammalian cells. Nature 385, 810-813 (1997).

[13] Thomson JA Itskovity-Eldor J: Embryonic stem cell lines derived from human blastocysts. Shambloty MJ, Axelman J, Wang S et al.: Derivation of pluripotent stem cells from cultured human primordial germ cells. Proc. Natl Acad. Sci. USA 95, 13726-13731 (1998).

[14] MacArthur BD, Oreffo ROC: Bridging the gap. Nature 433, 19 (2005).

Citation: Prof. Dr. Willie Sai Ho Chan, LLB, MD, (2022), "Then and Now: Regenerative Medicine --- A Short Over view", Arch Health Sci; 6(1): 1-5.

DOI: 10.31829/2641-7456/ahs2022-6(1)-009