

Stem Cell Therapy Perspectives

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Stem cells have self-renewal potential and ability to differentiate into one or more specialized cell types. An ideal candidate for developing stem cell based therapies would be readily available, easy to expand in culture, possess an acceptable long term safety profile and be autologous in nature, in order to avoid the need to modulate the host immune response and prevent rejection. Unfortunately, a cell type that fulfills all these criteria remains elusive, however, current research is directed towards a limited number of cell types which themselves exhibit certain advantages or disadvantages. Such cell populations may be sourced from three broad categories: embryonic or foetal tissue, adult tissue and reprogrammed cells. There are two broad types of stem cells, embryonic stem cells (ESCs) and adult stem cells. ESCs are isolated from inner cell mass of blastocyst which can transdifferentiate into cells of all three germ layers. Unlike ESCs, adult stem cells show restricted proliferation and lineage differentiation. Embryonic and adult stem cells offer the opportunity to transplant a live source for self-regeneration. Bone marrow transplants (BMT) are a well-known clinical application of adult stem cell transplantation for cancer patients. BMTs can repopulate the marrow and restore the blood's different cell types after high doses of chemotherapy and/or radiotherapy, which are used to eliminate cancer cells. An alternative for ESC are stem cells obtained from tissue after birth. Adult tissue-derived stem cells offer an alternative for the development of cell based therapies which circumvents the ethical controversies surrounding foetal and embryonic tissue. For instance, neural progenitor cells have been harvested from adult brain and spinal cord. However, adult stem cells are less plastic than ESCs and divide less frequently in culture. Also, their differentiation potential may decrease in time. This makes them a possible but somewhat limited alternative for ESCs. On the other hand, they offer the advantage that they can be transplanted without genetic modifications or pretreatments. The most common way of thinking about stem cells treating disease is through a stem cell transplant. Embryonic stem cells are differentiated into the necessary cell type, and then those mature cells replace tissue that is damaged by disease or injury. This type of treatment could be used to replace neurons damaged by spinal cord injury, stroke, Alzheimer's disease, Parkinson's disease, or other neurological problems. Cells grown to produce insulin could treat people with diabetes and heart muscle cells could repair damage after a heart attack. This list could conceivably include any tissue that is injured or diseased [1,2].

These are all exciting areas of research, but embryonic stem cell-based therapies go well beyond cell transplants. Considering the ability of stem cells to become any cell type, their potential use for cell replacement strategies is common sense. With the appropriate combination of (growth) factors (induction cocktail), ESCs can be used to obtain neurons and glial cells. Human ESC can be directed toward multipotent neural precursors, motor neurons, and oligodendrocyte progenitor cells. The latter were found to differentiate into mature oligodendrocytes *in vitro* and *in vivo* [3].

The first cell therapy product approved by the FDA under an accelerated approval procedure was Carticel in 1997 autologous chondrocytes are expanded *in vitro* before being reintroduced into a lesioned or degenerated cartilage area, with the goal of treating severe cartilage defects. This approach proved highly successful, even for large full-thickness symptomatic chondral injuries. ALS (Amyotrophic

lateral sclerosis, or Lou Gehrig's disease) is a degenerative disease that affects the motor neurons that connect the brain to the spinal cord and the spinal cord to the muscles in the body [4]. The disorder causes muscles to weaken over time. The main cause of death in ALS patients is not being able to breathe because the muscles can't be controlled. The hope for stem cell therapy for ALS patients is to use stem cells to replace damaged motor neurons or to stop the neurons from degenerating in the first place. Research groups has identified a type of stem cell, called an ependymal cell, in the spinal cord. These cells are inactive in the healthy spinal cord, and that the cell formation that takes place does so mainly through the division of more mature cells. When the spinal cord is injured, however, these stem cells are activated to become the dominant source of new cells.

The possibility of using stem cell-based therapies for people suffering an acute MI or living with CHF has captured the imagination of both the medical and popular communities. A number of promising cell types for cardiac regenerative therapy has accumulating preclinical and early clinical data supporting their potential. There are some major changes happening in stem cell therapies that are setting a new paradigm for regenerative medicine. The opportunity to repair and regenerate tissues injured by disease and trauma is opening the way to new optimistic treatments that need to be carefully evaluated in early clinical trials. The therapies that will emerge first are likely to address neural repair, macular degeneration, cancer targeting, problems of immunity, and cardiovascular disease.

References

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