Stem Cells: More Than a Cancer Treatment

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Introduction

Stem cell transplants have been used for many years to treat a variety of different health issues. They are most often known for helping cancer treatments, but more research is being done to show that they can also be useful interventions in other medical treatment. Stem cell transplant have been successful in non-cancer treatments for issues in the brain, heart, and eyes (Herberts et al. 2011; Rama et al. 2010). There are three main properties that all stem cells possess; self-replication, genetic constraints in expanding cell populations, and the ability to adapt for different organs (Clarke & Hass 2006). They are derived from a donor's bone marrow and inserted into the patient. This paper will compile evidence to suggest that stem cells are one of the up and coming advancements in the medical field.

Cancer Treatment

Cancer is a disease that results from an uncontrolled growth of cells somewhere in the body. It can affect almost any space in the body and can eventually lead to death. Many common therapies include radiation and chemotherapy, which are both highly invasive and toxic to the body. New research with stem cell transplants has been successful in improving the outcome of cancer patients (Dean 2006; Phi et al. 2018). Stem cell transplants have been most successful in treating cancers in the blood and immune system (Phi et al. 2018). At this time, leukemia is the most common type of cancer treated using stem cell transplants, but as the research with stem cells improves it is likely that successful treatments for more types of cancer will be discovered. Acute myeloid leukemia is a specific type of leukemia that affects the bone marrow (Koreth et al. 2009). It was discovered that a stem cell transplant was generally successful in achieving

remission in many adult patients (Koreth et al. 2009). This finding provides a new pathway for researchers all over the world to look at stem cell transplants as an alternative to treatments such as chemotherapy and radiation. These new findings continue to allow medical professionals to develop cancer treatments that are more affordable, more successful, and less harmful to patients.

Non-cancer treatment

Although stem cells are primarily known for their use in cancer treatments, they can also treat degenerative diseases in the heart, eyes, brain, and other parts of the body with damaged tissue (Herberts et al. 2011; Rama et al. 2010). In a study done by Rama et al, limbal stem cells were used to treat patients that experienced corneal damage. The cornea is an important part of the eye that allows light to enter the eye. When this is damaged, it can blur or fully eliminate vision in the patient. The damage originated from an injury to the limbus, which can cause a limbal cell deficiency and lead to inflammation, scarring, and eventually loss of vision (Rama et al. 2010). The limbal stem cells are taken from the limbus, a small area of the eye between the cornea and conjunctiva (Rama et al. 2010). The conjunctiva is a thin layer of the eye that is responsible for keeping the eye clean. Conjunctivitis (pink eye) is a common infection that involves swelling and redness of the conjunctiva. If left untreated, it can lead to life-long issues with the eye such as blurriness or blindness. Some of the patients in this study suffered from these effects. The results of this experiment showed permanent restoration of the cornea in 76.7% of patients (Rama et al. 2010). Follow ups were also done for ten years following the original transplant, and the successes remained that way. All of the failures that occurred were

seen within the first year (Rama et al 2010). The failures in the study were all able to be linked to issues with the eyes before the corneal injury.

Next, heart disease has been successfully prevented, and some cases it has been reversed, by using stem cell transplants (Segers & Lee 2008). Many current treatments for heart disease do not cure it, they just slow the progression (Roger et al. 2011). As many people know, heart disease is the number one cause of death in the United States. A therapy like this one can be life changing for many people in the US and around the world who suffer from heart disease. The stem cells transplanted into the patient are able to regenerate to match the different muscle types in the heart, which allows for better blood flow in and out of the heart (Segers & Lee 2008). This was an important discovery because it allows for a broader range of treatments for heart disease patients. If the stem cells did not evolve to match the heart muscle cells, it is likely that the heart would not function appropriately. Another study found that stem cell therapy reduced mortality and occurrences of myocardial infarction related to heart disease (Fisher et al. 2016). This is an important discovery because heart disease is one of the top causes of death around the world. Since heart disease is a very common and very deadly disease, the discovery of this successful treatment will change the future lives of people all over the world.

Stem cells have also been shown to improve the recovery of patients with brain damage. Brain injuries can impact the lives of not only the patient, but also the people around them. It is often a long recovery period and some patients never fully recover. With new treatments being tested, there is a great chance that brain injury recovery will become faster, easier, and more successful in the future. The majority of studies around the brain are focused on treating damage

from strokes (Velthoven et al. 2010; Velthoven et al. 2012; Liu et al. 2009). Using the nose as a minimally invasive way to access the brain, they injected bone marrow from the femur into damaged areas of the brain (Velthoven et al. 2010). Creating a less invasive pathway for transplanting the stem cells will make this procedure more enticing to patients. They found that overall brain function was improved and there was a reduction in gray and white matter loss (Velthoven et al. 2010). This experiment was completed in mice and has not yet been approved for humans however, it shows significant likelihood that it could be successful. Another study by Velthoven was focused on neonatal brain injuries caused by strokes. Neonatal brains are very immature, which leaves a lot of room for change during development (Velthoven et al. 2012). After adding mesenchymal stem cells, researchers found that they are a great option to treat brain issues in neonates. Mesenchymal stem cells have many properties that allow them to adapt to replace several types of damaged tissue in different areas of the brain. This, along with the flexibility of young brains, allows for a greater chance of recovery from an injury. The results of this study bring a large wave of new information for other medical professionals. Since brain injuries are a very serious injury, this new type of treatment is opening the pathway for further research and improvement in patient outcome.

Stem cells have also been used to treat spinal cord injuries. In one study, researchers used embryonic stem cells and injected them into rats with a spinal cord injury (Keirstead et al. 2005). This has not yet been tested in humans because it is still in the testing phase and long-term effects are not yet known. This study was successful, and the researchers found that the new cells were able to survive and repopulate the area that they were injected. The animals showed

increased use of their motor skills when the cells were implanted 7 days after the injury but when they were implanted 10 months after the injury, the results did not show a change in the use of motor skills (Kierstead et al. 2005). The results of this study are different than expected, but they have also opened up a new door for future research. The animals that received the cells after ten months did not have a recovery like the animals that received the cells seven days after the injury, so a future study could further investigate the reasons behind that. This would also be an important piece of data when beginning to use this method on humans because it shows how important quick intervention is to aid in the best recovery possible.

Downfalls of stem cell transplants

Like any kind of medical treatment, there are some risks associated with stem cell treatments. There is evidence to suggest that stem cells may be the start of cancer in some cases. Their ability to self-replicate, along with a longer life span, suggest that cancer may begin from a mutation in the target cell (Clarke & Hass 2006). These specific cells are called cancer stem cells, in their own class away from all other stem cells. This discovery was not surprising to hear because all treatments have a risk of some sort. In a patient with cancer, their only treatment options are often chemotherapy, radiation, or a stem cell transplant. All three of these treatments have side effects so it would be up to the patient and their medical team to decide which approach to take. The stem cell tumors have not been seen often, but new research continues to note them as a risk of receiving the transplants. The new evidence shows that a majority of the cells in these tumors cannot self-renew (Clarke & Hass 2006). The cells that cannot self-renew are not stem cells, so this is leading to more research about how exactly this is occurring and new

treatments to target the right cells (Clarke & Hass 2006). Cancer stem cells have been studied in recent years and have been identified in many different tumors (Phi et al. 2018). Stem cell tumors have come back as a relapse after a patient was cancer free. These tumors are often stronger and more resistant than other types of cancer (Phi et al. 2018).

Going back to heart disease treatment with stem cells, there was no decrease in the rates of rehospitalization or tests of heart function (Fisher et al. 2016). The treatment was successful but did not necessarily work better than previous treatments. While this is not necessarily a more successful treatment, it is another option for people that have already tried other methods. The stem cell transplant is a new way for doctors to help patients when they become immune to medication or have bad side effects from other approaches. While there is a risk associated with every treatment, it is up to the patient to decide if the benefits outweigh the risk. In any serious medical condition, the patients may be worried about the risks, but by consulting with their medical team they will be able to make the right decision for themself.

Since stem cell transplants are still in the experimental phase for treatment of many diseases, they can be very expensive. Many medical treatments are very expensive though, so this issue is not one that is limited to stem cell transplants. There will also be more likelihood that insurance will take part in covering some of the treatment once it becomes more readily used in medicine.

Conclusion

Overall, stem cells are becoming the newest reliable technology across the medical field. They are able to be used to transplant into patients who suffer from a wide variety of medical

issues including cancer, heart disease, and strokes. The data presented in this literature review suggest that stem cell transplants are often more successful and less invasive than traditional treatments such as chemotherapy. There are also some diseases that do not currently have a treatment, so stem cell transplants are being researched as a treatment. As more research is done, there will be more diseases that have treatments and it will likely become cheaper and more regularly used than traditional treatments. These discoveries are have changed and will continue to positively impact the lives of people all over the world.

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