The Cure of a Lifetime

Cassidy Resmen

A fourteen-year-old girl named Cody Unser hopes to dance at her senior prom, just as any girl her age does. The catch - Cody is paralyzed from the chest down and uses a wheelchair. She has a rare condition called transverse myelitis, which causes spinal cord inflammation that leads to paralysis (McCabe, 2001). No treatment exists for paralysis, but one may be on the way. Stem cells exhibit characteristics which cannot be found within any other cell in the human body; the cells can renew themselves through cell division and are unspecialized, meaning they can differentiate into any other type of cell (Cohen, 2007). These cells hold the potential to create cures for diabetes, spinal cord injuries, Parkinson's disease, Alzheimer's, arthritis, and potentially issues with the heart (Lo & Parham, 2009). Individuals are born into the world with a fixed genetic status and with certain environmental factors which influence various disease states (Kaji & Leiden, 2001). The entire paradigm will switch with the implementation of stem cells into the medical world. While the benefits reaped would be large, the ethicality of using stem cells for medical treatments has not been determined. The world must make the difficult decisions of which technologies align with ethical boundaries. I am going to highlight the background of stem cell research, discuss the ethical issues of the research, and portray the scientific community versus the religious community's views. I also will discuss current research methods as well as the regulations which have been implemented. Lastly, I will discuss foreign policies and recommendations based upon current policy and foreign countries. The recommendation includes forming an ethics committee composed of various members of different expertise in order to form regulations which suit all parties.

Background of Stem Cells

The most important step of discussing the ethicality of using stem cells is understanding what they are. The entire field of stem cell research remains relatively new. The field developed a little over 60 years ago when a scientist, Leroy Stevens, noticed a lab mouse with a huge scrotum. (Bodach, 2004). Upon closer examination of the tumor contained inside, Stevens saw a rare tumor called a teratoma. He later discovered the tumor originated from an embryonic stem cell.

Stem cells do not only come from embryos, two types actually exist. McCabe (2001) explains the differences between the two major types: adult and embryonic. Adult stem cells reside in skin, the heart, and blood cells. Research involving these cells is less controversial because extraction of them does not cause the donor to die. Although they may seem the better choice, these stem cells do not hold the ability to multiply and grow into any cell type. Adult stem cells have started down the path of specialization and can only morph into a limited range of cells.

Embryonic stem cells come from the earliest stage of a fertilized egg and stem cells can be harvested shortly after fertilization. According to the article "Super Cells" (2001), embryonic stem cells are the most flexible kind of cell. They form clusters of 10-20 cells which eventually grow into a baby. Embryonic stem cells can morph into any kind of cell because they have not become specialized; they can become any of the 200 types of human cells. The extraction of the stem cells results in the death of the embryo.

While the issue of stem cell research may seem far away, the discussion becomes particularly important for the United States. Lysaght et al. (2018) describe the story of Sheila Drysdale. The 75-year-old woman received a stem cell treatment for her advanced dementia.

The procedure involved removing adipose tissue from the patient and processing them in order to create stem cells to be administered. Sheila died three hours after being discharged from the hospital. Her death is significantly controversial because the "procedure" held no past evidence of success as a treatment for dementia. Her case shows the failure of the United States to address the ethical uses of stem cell research. White (1999) argues that the United States has been forced into being the frontrunner for making regulations and protocols for stem cell research. The United States has the most published articles focused on stem cell research with high field-weighted citation impact, (Farajkhoda, 2017). White (1999) states this becomes even more difficult because the research began before any regulations were set in place. The United States must determine the ethical guidelines first and then how the individual research will be approved and monitored.

Ethics of Stem Cell Research

My next point comes with discussing the ethics of using stem cells for research and medical treatment. Many recognize stem cells as the future of medicine, however issues within the field still need to be settled and boundaries need to be set. The worlds of religion and science collide in the discussion of stem cells. Graf (2012) portrays the perspectives of science and religion. In the extraction of stem cells from embryos, the embryo is destroyed and unable to develop into a human. Science diminishes this reality by stating the embryos are too undeveloped to be guaranteed the same rights as a human has. I argue the issues between the two perspectives can be dissolved and a compromise can be made by each opposing side. As McCabe (2001) states, we cannot predict which experiments will lead to the therapeutic tools doctors need to treat incurable diseases, but that does not mean we should give up hope. I will

discuss issues with obtaining stem cells, different techniques which can be used, and rights of the embryo.

Obtaining Stem Cells

A large part of the controversy of using stem cells comes from the methods of acquiring them. Stem cells can be harvested through three different methods: embryos, adult stem cells, and reprogramming of an adult stem cell in order to create any type of cell. Embryos used in research come mostly from donations by couples going through in-vitro fertilization treatments or through creation of the embryos for specifically for research. Each one raises moral dilemmas.

When a couple undergoes in-vitro fertilization, not all of the embryos go to use. The couple then has the options of either donating the embryos for another couple to use, donating the embryos for research, or allowing the embryos to die. The viewpoint lies on whether or not one sees the embryo as a human yet or not. Allum et al. (2017) discuss the two perspectives as the "sanctity of life" ethic and "quality of life" ethic. The sanctity of life ethic resides with the religious perspective on life. The proponents of this side view the embryo as a human being that possesses rights which cannot be taken away. The quality of life proponents argue that the cells hold the potential to relieve the suffering of those alive now and could lead to cures for serious diseases, which then means it is unethical to not use the cells.

McLaren (2001) also discusses creating embryos for research. A sufficient amount of embryos cannot be gathered from leftovers of in-vitro fertilization, making the need for other methods to be explored. One way of making these cells happens by fusing the nucleus of a somatic cell from a human with an egg and removing the egg's nucleus. This cell then multiplies and makes identical cells to the mother cell; this method is named somatic cell nuclear transfer

(SCNT). This technique is also used in cloning, which creates controversy in itself. The method has benefits - because the somatic cell comes from the person's own body there is less chance of rejection. The major dilemma with this technique is that it also requires a large supply of unfertilized human eggs. SCNT still remains an inefficient process, meaning a large amount of those eggs go to waste. Faden et al. (2003) reveal other hidden issues behind this technique. While this method could provide customized stem cell match therapies, the economic and logical considerations reveal the method is not as great as one might think. The technique does solve the problems of rejection of stem cells, but the process remains highly expensive. In addition, scientists could never have enough time to create these unique stem cells for everyone as a treatment.

Adult stem cell therapy holds issues as well. Skene (2010) dives into adult stem cells; the genes used to reprogram the cells have been associated with cancer. Eric Forsberg of WiCell Research Institute reported that reprogramming adult stem cells is inefficient and not entirely complete. He says the method can cause health problems such as the case with Dolly the cloned sheep. This method also calls for an individualized treatment because each person's genome can only be reset to a certain extent. The benefit to this technique lies in that no eggs need to be used in order to create the pluripotent cell. An adult cell is reprogrammed into a stem cell. None of the methods are perfect, but each one generates different pros and cons when contributing to stem cell research. Stem cell research holds the potential to treat previously incurable diseases. I argue alongside the quality of life perspective, we must pursue stem cell research in order to find these cures.

Rights of the Embryo

Stem cell research leads the world to ponder the question of when humans obtain rights. If not at the point at conception, then how far along? Religious opposition of the research equate using stem cells to aborting a baby. Kuhn (2002) discusses the importance of removing embryonic stem cells from the religious abortion debate. Stem cells derived for research purposes will never reside within a woman's body. Most countries, including the United States, deem human embryos usable for research until 14 days after fertilization. After the fourteen days, the embryos must be terminated. The 14th day after fertilization becomes important due to the fact that this is the last point in which the embryo could cleave into twins, the beginning of gastrulation (multilayered structure), and the point before the formation of the brain and spinal cord (Cavaliere, 2017). Due to the controversy, scientists have focused on other avenues of creating stem cells rather than obtaining them from embryos. Studies show 51% of Americans say it is more important to conduct stem cell research which could result in cures for diseases rather than avoid destroying the potential life of human embryos (Vestal, 2008). Magill and Neaves (2009) take the issue further and discuss the ethical concerns of embryonic stem cells versus somatic cell nuclear transfer (SCNT) cells or induced pluripotent stem cells (iPS). These two types of cells are two alternate avenues for which stem cells could be obtained. Induced pluripotent stem cells are created by taking a cell from an adult and reprogramming the cell to be similar to an embryonic stem cell in that it can become any other kind of cell. Scientists felt relief after creating iPS cells because they felt this relieved them of the ethical burden of using embryonic stem cells. The creation of iPS cells does not call for the destruction of an embryo. However, the reprogrammed iPS cells hold the capability of turning into a fetus, as do the SCNT cells. The ethical dilemma of protecting embryos still holds prevalence over these techniques.

Stem cell research has obvious potential to provide advanced medical treatment. Magill and Neaves (2009) then argue the use of iPS cells or SCNT cells cannot be prohibited. The absurdity in protecting naturally made embryos, but then also not allowing artificially made embryos to be used in research does not allow the scientific community any angle to use. iPS cells cannot provide their own placenta and will die if not supported appropriately in a lab. Totipotent cells can make their own placenta, pluripotent cells cannot. Scientists have not focused on making totipotent cells because they only need pluripotent cells for medical therapies involving stem cells. No current effort to make totipotent cells is known about. Opponents of embryonic stem cell research have shown support for iPS cells, which suggests that the protection of a human life begins later than at cellular development. This viewpoint is also supported by various countries that allow creations from stem cell research to grow for fourteen days before being destroyed (McLaren, 2001). Religion and science will always collide within this field of research. However, the scientific community needs to be allowed to find the treatments our world hopes for.

Science in Society

Support for stem cell research has grown, but still has a high disproval rate. I argue much of the public opposes the research due to lack of knowledge on the topic or education on the benefits to research. These advancements in stem cell research put scientists in the position where they now need to communicate effectively with the public. London (2002) argues scientists will not elicit public support until the scientific community recognizes the public not only has to engulf an entirely new vocabulary, but accept a challenge to their moral reasoning as well. Other topics, such as abortion have infinite information about them available, but the topic of stem cell research remains fresh. What London argues then is that the public rejects the idea

of stem cell research not only because of their moral reasoning, but also lack of understanding of what the research entails. If scientists could discuss the research with the public in simple terms, the research could gain more momentum.

Communication with the public would also create a better bearing of what the medical techniques entail for the future. Shineha, Inoue, Ikka, Kishimoto, and Yashiro (2018) conducted a large scale survey involving the public's and scientific communities on stem cell research. The results of the survey show the public believed the technology would be implemented within 10 years, whereas scientists believe the actual time span to be closer to 20 years. The study also revealed the public places more importance on the risk of the medical care involving stem cell research as well as the cost of care. The highest importance according to the scientific community was the importance of scientific validation and the necessity of the research. These studies show a large gap between the public's understanding of the research and the scientific community's intentions. This shows the technology could benefit largely from better informing the public and revealing more information about the research happening. Trench and Miller (2012) discuss ways of bridging the gap between scientists and the public. Various countries in western Europe have national policy which holds the scientific community accountable for informing the public about scientific advancement. A specific example is Denmark, which passed a law in 2003 requiring the scientific community to release their knowledge of academic methods and results as well as exchanging their knowledge amongst other scientists and partaking in public debates. The United States could learn a few things from those European countries. The public cannot be expected to support stem cell research until the scientific community steps out and informs the public. The research can be integrated into society once support for the methods.

Currently Used Techniques

So how has our society currently implemented stem cell research? Stem cell research and experimentation reaches farther than most would think. While the techniques are young, the potential benefit to the society is large. Levine and Grabel (2017) discuss the usage of chimeras. This form of research involves combining a human's stem cells with an animal's cells to form an embryo. This method has been used to investigate areas of biology, cancer, and immunology. The stem cells derived from this method provide scientists with a way of testing out different treatments for the diseases on cells similar to a human's. For example, the stem cells could be used to make cardiac tissue to test treatments for damaged heart muscles. Wu and Belmonte (2015) also discuss the use of chimeras for in-vivo drug screening. One method of drug testing can be done using patient samples and immortalized cells. This method is limited by availability of samples as well as issues such as genetic abnormalities in immortalized cells. Chimeras, such as human cells mixed with a mouse, can be used for drug testing platforms. This is still a limited model due to the anatomical and physiological differences between humans and mice, but the tests done on them so far have proved to be beneficial. Other forms of chimera experimentation have also shown efficiency in the production of various types of cells from the stem cells derived from chimeras and the ability of transplanted cells to survive within the host. Type I diabetes results from the loss of a beta pancreatic cells due to a response from the body, which then affects the ability to produce insulin. Pre-clinical studies involving mice display the way stem cells derived from chimeras can enable their pancreas to efficiently produce insulin once again and treat diabetes.

Success has been shown with various types of stem cells. Lo and Parham (2009) discuss hematopoietic stem cells, which are stem cells which can give rise to any blood cell, show

promise treating leukemia as well as cell-based treatments for burns and corneal disorders. Tesler (2001) discusses an experimental treatment involving two boys with a disease that causes their immune systems to attack their organs. The boys were injected with stem cells in order to rebuild their immune systems so they no longer attacked the organs. The doctors had the option of using embryonic stem cells, adult stem cells, or cord blood stem cells. Due to the case, the doctors chose the cord stem cells as the best candidate. The cells can be obtained from the umbilical cord of a newborn. Experimentation involved many risks, but the doctors decided this to be the best hope for the boys. Four years after the injection, the doctors declared the boys cured and healthy.

Stem cell treatment has also shown success in other species. Jozefowicz (2005) writes about Comet, a dog who received this medical treatment technique after being diagnosed with cancer. Comet remains one of few dogs to receive a stem cell transplant as treatment rather than a precursor used to perfect the technique in humans. The dog from Seattle was diagnosed with lymphoma after his owners took him to the veterinarian. Lymphoma is a cancer involving the lymphatic system and lymphocytes. The lymphatic system aids the body in fighting infections and lymphocytes are blood cells that help out in the fight. Usually, chemotherapy would be the technique used to fight this cancer. Comet underwent chemotherapy, but the harshness of the radiation can cause detriments to one's health. The doctors insisted on putting Comet down, but his owner's fought for another option. Finally, the treatment of a stem cell transplant was agreed upon. Comet received hematopoietic stem cells to help replace the diseased lymphocytes which would be killed by radiation before the transplant. After his treatment, he developed graft-versus-host disease. Basically, Comet's transplanted tissue attacked his own body. The doctors were able to control this using medication. One year after the transplant, Comet was reported

cancer free and no longer had to take any medications. The current implementations of the technology show great success, but the technology remains held back by incomplete legislation and policies developed by the United States.

Policy and Implementation

Stem cells will continue to advance the medical world for time to come. The next step resides in deciding exactly how far to take this prospective technique of medical treatment. As stated earlier, the United States has yet to come to finalize ethical boundaries concerning stem cells. Bobrow (2005) describes stem cells as the heart of genomic revolution that will alter medical treatments forever. He also discusses guidelines for policies to be implemented in response to the growing build up around stem cells. Bobrow argues three issues for which a consensus must be reached and policy implemented. First, scientists involved with the research need to open up to the community and present their views on the pros and cons to the research and tell who will benefit, who will suffer, where the stem cells can come from, and what uses the stem cells provide. Second, the line between stem cell research and cloning needs to become clear. Third, scientists need to address the opposition's arguments and clarify the goals of stem cell research as the preservation and improvement of life. Bobrow also highlights the National Academies proposition of a way to procure stem cell research regulations which would meet a majority of the people's approval. They propose a national forum where individuals from various backgrounds such as science, medical, ethical, and legal come together to set guidelines that would guarantee a distribution of benefits and sufficient genetic diversity. A committee would oversee all stem cell research to ensure everyone follows the regulations. In theory, this would cover all bases and ensure each side of the argument is addressed within the laws and regulations.

Current United States policy deems producing human embryos for research purposes as illegal. Human embryos can be used for research purposes up to 14 days after fertilization, because after the 14th day the cells begin to differentiate. The United States approves of research on human embryos donated by couples undergoing fertility treatment. President George W. Bush procured a bill allowing the funding of research on 64 lines of research that were then being conducted, but none established after August 9, 2001 (McLaren, 2001). President Bush later took a strong stance and eliminated federal funding entirely from stem cell research in 2005 (Skene, 2010). In 2009, President Barack Obama overrode President Bush's bill and allowed federal funding on spare human embryos. He also took a stance on allowing human embryonic stem cell research, he implied that the destruction of embryos for the use of healing the sick does not devalue human life (Majumder & Cohen, 2009). The United States does not currently ban the creation of human-animal embryos, but other countries such as Australia, Canada, and various European countries do. The United Kingdom created the first human-animal embryo in 2008. These embryos still abide by the 14 day termination rule.

Other countries fare better with developing legislation for boundaries of stem cell research. The United Kingdom, Israel, Canada, Singapore, and many others have a thorough outline of the laws for the research (Bobrow, 2005). Other countries such as France, Germany, and Sweden have developed more limited policies. Italy and Poland completely ban stem cell research. Allum et al. (2017) discuss the results of a study done to measure support of stem cell research between countries. The study found Europeans were the least supportive of the research at only 62 percent support while the United States had a 73 percent approval rating, and Canada had an 81 percent approval rate.

Farajkhoda (2017) analyzes stem cell research guidelines and their implementation in Iran. Islam encourages the use of scientific research to find cures or preventions for human disease. As a result, Iran approves of stem cell research. The techniques used have been sculpted by religions, cultural, and social opinions concerning when a human life begins. The ethical issues of stem cell research in Iran are debated and resolved between medical physicians and religious scholars. Iran has ruled making embryos for research purposes illegal, and they only allow the use of human embryos below 14 days that were created through in-vitro fertilization techniques to be used. Since the research has been declared legal, Iran has made considerable advancements and also implemented national policies. They collectively came up with a code of medical ethics as of 2002 for the scientific community to follow. Iran also has "ethics committees" who evaluate the ethics of new medical techniques. Farajkhoda (2017) defines a 'Research Ethics Committee':

> A 'Research Ethics Committee' is defined as a multidisciplinary, independent, body charged with reviewing research involving human participants to guarantee that their dignity, rights, and welfare are protected, through reviewing research proposals, monitoring the conduct of research and dealing with problematic issues that may arise from research. They should be familiar with biomedical research principles (p. 69).

These committees are used throughout universities of medical sciences and at the national, regional, and local level in order to keep scientific advancement within the ethical boundaries of Iran. Farajkhoda (2017) finishes his argument with recommendations for stem cell research based upon Iran. He suggests that ethical suggestions for stem cell researchers come

from studies and appropriate collaboration with ethics committees. Legislation must be formed at the national level and the ethical guidelines must be updated. The guidelines need to be formed by a cooperative group made up of religious scholars, physicians, philosophers, legal experts, sociologists, and other interested academics. Shah et al. (2018) argues for the same implementation of an ethics committee, but also includes ethicists, scientists, and the community within the group that should overview the research. Iran's usage of a religious perspective provided cultural adaptations to the stem cell research, making it structured towards the people and norms of the society.

Implementing new policies takes patience and cannot be done within a short time period. Young (2000) suggests applying a three year moratorium on human embryo research while a committee reaches a consensus on a national policy. He also discusses giving the scientists involved in research on human adult stem cells and animal embryonic and germ cells sufficient funding during the moratorium in order to allow them to advance. This gives policy the chance to catch up to the current scientific advancements. Once we develop appropriate policies, stem cell research will be able to progress and begin benefitting the public.

Conclusion

Cody Unser could dance at her senior prom with help from a stem cell treatment. Cody's case is only 1 out of over 100 million cases which could be treated by cell transplantation technologies using stem cells (Perry, 2000). After obtaining a better understanding on stem cell research, I now can discuss recommendations as our future begins to intertwine with these cells. We cannot ignore the potential medical treatments which would emanate from further research within stem cells. Diseases which have befuddled scientists for centuries could finally be treated. The use of embryonic stem cells should not be overlooked; using embryonic stem cells

may cause death to an embryo, but could save many lives. I do not condemn producing these cells or obtaining them purely for research, but I do believe using leftover cells from in-vitro fertilization puts the cells to a greater purpose as long as the donators are aware of what the cells will be used for. Adult stem cell research and reprogramming should be funded and focused on heavily. This method has the potential to solve much of the controversy surrounding the research and will only gain momentum through continual support.

While the public shows some support for the research, I believe the scientific community needs to take matters into their own hands and arrange for public forums on the topic. As discussed earlier, the public cannot be expected to support the scientific community on a concentration in which they lack knowledge. Improved communication between the public and scientific community will increase success of the research. Current implementations of the research show huge successes, which will only continue to progress.

Lastly, I will touch upon policy recommendations. While the United States remains a forerunner in the world of stem cell research, we have yet to establish a solid national policy. We could benefit greatly from forming an ethics committee which would oversee stem cell research and ensure rights of everyone involved. The committee should be composed of physicians, ethicists, scholars, philosophers, legal experts, scientists, and a representative for the voice of the public. This would ensure all perspectives are considered in making policies and ensuring stem cell research stays within ethical boundaries. I also agree with the suggestion of implementing a moratorium for a short time period on embryonic research in order to decide what boundaries the United States would like to set. Policy must progress before research does in order to keep a hold on the technologies. Stem cell research holds the potential to turn our

world inside out and provide amazing medical technologies, we only need to learn how to direct it towards a path which will be the most beneficial to society as a whole.

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