Gene Therapy: Possibilities and Ethical Implications

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Introduction

A young man has learned that he has contracted HIV: the virus that causes AIDS. He is not afraid of the diagnosis because what was once considered a death sentence has now become a minor inconvenience. One week later, he is admitted to the hospital for a minor procedure. During this procedure, the doctor injects the young man with new cells that contain genetic material resistant to the HIV virus. After this procedure, the new genetic material alters his cells, causing the virus to be completely neutralized. On the same day, at the same hospital, an expectant mother is picking out the sex and eye color of her baby from a catalog. She has four boys at home, and she desperately wants to bring home a baby girl with big, blue eyes to her brood of boys.

It is entirely possible that in the next few decades, these scenarios may, indeed, become reality. New breakthroughs in the fields of reproductive science and gene therapy are bringing humanity closer to having control over its own genetic make-up and therefore, its own destiny. While many scientists and proponents of these new technologies are excited about the possibilities of curing disease and improving lives, many others fear the repercussions of tinkering with the genetics of human beings. New research in genetics is, in essence, “transforming the way people view themselves and, even, the human condition” (Begley, 2010, p. 68). Some believe science is going too far in the quest to create healthier, happier human beings. They fear that what begins as a genuine effort to cure people of deadly disease will turn into an obsession to design and create superior people. Those with more humanistic viewpoints believe that to deny society the possibility of improvement through this new technology for medical, cosmetic or other reasons would be robbing humans of their potential. The study of gene therapy promises breakthroughs in the treatment of illnesses and the improvement of our
quality of life; however, there are numerous ethical concerns that need to be addressed as the technology advances.

**History of Gene Therapy**

The early beginnings of gene therapy that have led these ethical questions of today began not with the work of a 20th century doctor or scientist, but with a 19th century Moravian Monk, Gregor Mendel. In the 1860s, Mendel began his exploration by cross breeding different species of garden pea plants with specific traits such as seed shape and color. He began to observe that hereditary traits did not diminish in the next generation but remained intact in proportional amounts according to whether the trait was dominant or recessive. These traits were determined by the properties that are now identified as genes (Kelly, 2007).

The next revolutionary step in genetics came in 1927 when American geneticist, Hermann Joe Muller, conducted experiments with fruit flies. In these experiments, fruit flies were inundated with X-rays, resulting in mutations in their genetic make-up. These studies proved that genes could be changed by outside forces. By the 1940s, it was confirmed in the scientific community that genes held the instructions for making proteins. Any mutations occurred when genes that were altered in some way created atypical proteins (Cooper, 2000).

Perhaps the greatest achievement in genetics, and arguably for science, was the discovery of the structure of the DNA molecule. In the 1950s, James Watson and Francis Crick discovered that the DNA molecule resembled a long double helix connected by four base pairs: adenine, cytosine, guanine, and thymine. This discovery transformed how science viewed the study of genetics (Cooper, 2000). The science of exploring DNA, evolved further by mapping the human genome, which was completed by the Human Genome Project on June 6, 2000. The genome is composed of all the body’s genetic material. Each genome contains about 40,000 to 80,000
genes that order the manufacture of one or more proteins. These proteins are responsible for carrying out all of the body’s vital functions (Cooper, 2000). By understanding the genome, scientists could now begin identifying genes that caused certain traits. Those traits perceived to be positive could be accentuated. Those deemed undesirable, whether for health or cosmetic reasons, could be suppressed. If these genes could be identified, scientists could research possible ways to turn specific ones on and others off to prevent disease or to shape human traits. However many advances are made, there are those who debate whether we should be conducting this research at all.

**Ethical Concerns**

Marcy Darnovsky, an ethicist representing the Center For Genetics and Society, is highly critical of procedures that alter the DNA of future children. She states, “It is a slippery slope, and once these experiments are conducted, there may be no turning back” (NBC Today Show, 2010, 0:55). As more is learned through these experiments, the ethical concerns of gene therapy remain. Is it safe to alter the DNA of a human? By doing so, are researchers, in a sense, “playing God”? Under what circumstances is altering one’s DNA acceptable? Science columnist Robert Bailey proposes using the “reasonable person standard.” He believes that before using any form of genetic enhancement, we must determine what the typical reasonable person would find acceptable. For example, many might condone using gene therapy in the prevention of future disease in unborn children; however, these same people might find it unreasonable to clone a human. Bailey (2002/2006) states, “Applying a reasonable-person standard to genetic enhancements should allay the more lurid fears of biotech opponents” (para.11). Unfortunately, applying this standard is easier said than done. What is reasonable to one may be completely unreasonable to another.

*Note: If the author, year, or page number is included in the narrative, you do not have to include it in the citation.*
Thus far, scientists have emphasized on the less controversial practice of curing or treating medical conditions. After years of false starts, progress has been made. For example, a young boy, Corey Haas, was born with retinal disease, and by the time he turned seven years old, he was almost blind. Corey underwent an experimental procedure receiving new genetic material in his left eye. His vision improved dramatically. The young boy can now play in little league baseball like his peers (Belluck, 2009). This procedure is being conducted on an experimental basis with many patients. It is unclear how many people with vision problems could be treated with gene therapy; however, the results have been promising so far.

Scientists are also experimenting with treating other diseases such as pancreatic cancer. In recent experiments, scientists were able to inject mice with a self-destruct gene that makes the cancer cells “commit suicide.” The tumors destroy themselves because the genes contain the instructions to do so. Over 37,000 people a year are diagnosed with pancreatic cancer, and it has one of the lowest survival rates of all forms of the disease (Barry, 2007). If this treatment were to become successful in managing pancreatic cancer in humans, it would be a major breakthrough in the study of oncology. Pancreatic cancer would no longer be a death sentence, but a treatable condition that could be managed or even cured (Barry, 2007).

Besides cancer, another condition that affects millions of Americans is Alzheimer’s disease. It is estimated that 5.3 million people are living with Alzheimer’s in the United States. This debilitating disease causes the brains of the afflicted to deteriorate resulting in dementia and memory loss (Alzheimer’s Association, 2009). Until recently, there was little that families could do for their loved ones other than watch them decline, and finally, succumb to the disease. In 2005, a study was conducted where scientists injected extra copies for the genes that grow cells into the brains of Alzheimer’s patients. The gene that was added was encoded with nerve growth
factor, which is a protein that preserves cells and encourages signals between brain cells (Seppa, 2005). The results showed evidence of neuron regeneration over a period of two years. While this treatment would not prevent or cure Alzheimer’s, it would hold off the progression of symptoms and allow the patients more time with their loved ones.

**Controversies**

Despite these successes, there is still much debate about gene therapy. One of the main concerns of those who oppose gene therapy, and even those who find it to be promising, is whether or not these procedures are safe. Gene therapy is still, in many respects, an experimental science. Though many tests have been conducted on mice and other animals, limited experiments have been done on people. There is no guarantee that a mouse will have the same reaction to experimental gene therapy as a human being. Another concern is the adverse reactions these treatments can cause. For instance, one of the most frequently used methods is to inject patients with the cells containing an inactive virus. In some cases, this treatment can cause immunity problems. Some possible side effects include inflammatory disorders and toxicity (Barry, 2007).

Opponents of gene therapy argue that the risks of these types of experiments are too great and, therefore, should be halted (Sadler & Zeidler, 2004). In order to understand how these procedures will affect human beings, people must be used in experiments. The question is this: Who will be the guinea pigs?

Those who advocate for giving these unproven, and possibly dangerous treatments, could make the case that no procedure is 100% safe for everyone. It is also unclear what level of safety is acceptable for a treatment to be used on a routine, or even experimental, basis. If there is a possible treatment that has any possibility of helping the friend or family friend with a terminal disease, why not give it a try?
Although the safety of these procedures is a concern for people on both sides of the debate, more disturbing to those opposing gene therapy is the idea of altering or even creating human life with gene therapy and other forms of genetic engineering. One idea that has been explored is cloning. In 1996, Dolly the sheep was the first mammal to be born as a result of cloning. Although she lived only a few years, this event led to the belief that cloning a human being was the next inevitable step (Masci, 2001). Some scientists feel that cloning would be a good way to harvest organs for sick patients. Opponents of gene therapy are absolutely horrified that human material would be generated essentially for “parts.”

Then there are those who want to clone a complete living human being. Many parents who have lost a child might decide to create a clone of that child in hope of bringing him or her back to life. Although the clone would be genetically identical, he or she would also be an individual who would be influenced by his or her environment. Scientists may decide to create clones of world leaders or geniuses who have since passed. However, there would be no guarantee, or likelihood for that matter, that these “copies” would gain the status of the original human being. For example, if a clone were created from the DNA of Albert Einstein, one of the most brilliant men in history, there may be potential for the clone to be as gifted or talented as the original; however, with different parents and a different upbringing, he could turn out to be any number of things. Perhaps he or she might become an evil dictator. Perhaps that person would choose a different career path and become a farmer or a teacher. Opponents argue that cloning human beings for any purpose, however noble the intention, would be “playing God” and that we have no business artificially creating human beings for our own purposes (King, 2009).
Some people feel that it is inevitable that scientists will want to use genetic engineering for the purpose of designing or altering human traits in children, such as appearance or intelligence. Currently, the technology to choose the sex of a child is available from the Fertility Institute. The process, described by the company’s official website, is surprisingly simple:

Several eggs are extracted from the mother by our doctors; sperm is supplied by the father. The father’s sperm is used to fertilize the mother’s eggs in our lab. After 3 days, several 8-cell embryos will have developed. Our doctor-scientist specialists examine the genetic makeup of the embryos, screening for both genetic diseases and desired gender. Healthy embryos of the gender you desire are implanted in the mother. Any additional healthy embryos may be cryo-frozen for future use. Gestation and birth take place as normal. (Sex Selection and Family Balancing section, 2010, para. 3)

The Fertility Institute says that the process offers “a desired pregnancy gender outcome that ranges from excellent to virtually guaranteed” (Sex Selection section, 2010, para. 4). Those parents who have had several children in order to have a boy or a girl will now get their wish. But what does this mean for the balance of gender in our society? There are generally about as many males as there are females in the world. If people begin to choose to have more boys or girls, what will happen to the sex that is the minority? For example, the fewer females there are, the fewer mothers there are to birth babies. It is plausible that such a phenomenon could drastically change the balance of nature.

Critics also question the ethics of using this technology to improve the quality of life of otherwise healthy people. However, others believe that the idea of making people “better” is worth exploring. What is agreed on by all concerned parties is that once we have the ability to “improve people,” the concept of being “human” will change forever. Sharon Begley, a well-
known author states, “The parade of discoveries in genetics is transforming the way people view themselves and even, the human condition” (1998, p. 68). With these new abilities, human beings will have power over their own destiny. Natural selection and evolution will no longer be the only factors to determine what traits are passed on and which ones will die out.

Another controversial topic is the issue of somatic versus germ line therapy. Currently, the medical procedures conducted have been somatic. When doctors use somatic gene therapy, they are only affecting the genes of that particular person. For example, if someone is receiving somatic therapy for sickle cell anemia, only his or her genes will be changed. The more controversial method is germ line therapy. In this case, the changes made to the gene are also passed down to the offspring of the patient. If a mother has a procedure that eliminates or changes the genes for a specific disease, such as Huntington’s, this gene would also be changed through the entire blood line, eliminating the need for future generations to battle the condition (Kelly, 2007).

Those parties who agree with using germ line therapy to change the genetic material through generations note several positive factors. One valid argument is that it is far less expensive to do a procedure affecting the germ line rather than treating diseases like Parkinson’s for generations to come. Also, future generations would not be forced to suffer through debilitating diseases. Why should patients have to suffer if these diseases can be prevented? There is strong resistance by others to alter the genetic material of future generations. The opposition’s view, overall, is that genes do not exist in a vacuum. To think that science can alter one or more genes of a person without affecting other genes or systems within the body is, in their opinion, erroneous. Also, by saying that changing a few genes can cure a person of all of his or her defects, people are ignoring the important role that the environment plays in becoming
who we are. The issue of changing the course of an entire hereditary line has clearly garnered strong opinions from both sides of this debate.

**Conclusion**

The changing of our genetic code is, perhaps, one of the most debated scientific controversies of our generation. Whether one is for or against the practices of gene therapy and genetic engineering, this one fact is undeniable: If and when these procedures become commonplace, the man with HIV will not have to worry about contracting AIDS, and the expectant mother will be able to select the sex and eye color of her child. The concept of being “human” as we know it will never be the same again. The question is whether or not humankind will be ready.
References


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