The Promise and Peril of Genetic Engineering

College of Saint Benedict/ St. John's University

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Nikolas Thompson

There have always been diseases and illnesses that have threatened society with no common cure and no way to eradicate such epidemics. Recent developments, however, may hold the key to defeating the plagues that haunt our species. Genetic engineering may be the answer. While today only in developmental stages, genetic engineering has potential to become a future tool in medicinal practice. The application of genetic engineering, however, is a double-edged sword. While it could be used to save lives, it could also be used to enhance the makeup of others. Genetic engineering applied in medicine is the only ethical and justifiable application, whereas being used as an enhancement tool is an unethical and irresponsible use of powerful technology.

Genetic engineering is a targeted genomic alteration that produces a desirable outcome in a living organism. Gene therapy is the restoration of genetic sequences in organisms. The main difference between the two is based on the purpose the technology is used for ("Gene Therapy and Genetic Engineering", 2016). Gene therapy seeks to simply correct the genetic sequences that are already present, while genetic engineering is used to alter a genetic sequence in an organism. These concepts have a potential range of application in humans spanning from coding self-destructing cancer cells to changing an un-born child's eye color to a desired shade of blue.

Human genetic engineering has picked up great speed in development since the early 1980's (Gordon, 1999). It is young in its human application and trials but shows promise. Gene therapy on the other hand has already seen some human application starting as early as 1990 (Wirth, Parker, & Yla-Herttuala, 2013). For the purpose of this paper, genetic engineering and gene therapy will be collectively referred to as genetic engineering, unless a distinction is necessary.

The Crispr-Cas9 Method

The most important aspect of genetic engineering is the methods used to achieve desirable and reliable results. The most recent and effective method is known as the CRISPR-Cas9 method. According to Mahmoudian-sani, Farnoosh, Mahdavinezhad, & Saidijam, (2017) CRISPR stands for clustered regularly interspaced short palindromic repeat, which refers to the repeated sequence of DNA found in bacteria. Cas9 nuclease is what cuts out a specified genomic sequence to be edited by CRISPR. CRISPR was first discovered in 1987 in E. Coli. It was later that the complete system of CRISPR-Cas9 was discovered in *Streptococcus pyogenes*, a flesh-eating bacterium (Mahmoudian-sani, et al., 2017). Within S. pyogenes, CRISPR-Cas9 is used as a sort of immune system. Foreign DNA within S. pyogenes are cut and captured by CRISPR-Cas9, preventing the invading DNA from damaging the bacteria (Mahmoudian-sani, et al., 2017). In a laboratory scene, this process can be further specified through the addition of a guide RNA or gRNA used to complementary base pair with a specified DNA sequence (Mahmoudian-sani, et al., 2017). CRISPR-Cas9, therefore, is used as a way to cut out specified DNA sequences to be edited or destroyed. The CRISPR-Cas9 system can be applied in several diverse ways across several different organisms.

Application of Genetic Engineering

This method of altering a genome to obtain a specific physical response, can be used to advance our medical practices. There is a great amount of potential for power over the human body with genetic engineering. With this power, there is also an enormous potential for abuse. However, if the use of genetic engineering is limited to healing and preventing major illness from hindering human lives, then the sky is the limit. I believe the medical application of genetic engineering shows promise and cannot be hindered by the potential of others abusing such technology.

Medical Applications

In my opinion, the most important disease that has potential to finally be cured through genetic engineering is cancer. According to the Mayo Clinic Staff (2018), cancer is caused by DNA mutations within cells, which cause the cells to divide rapidly and uncontrollably. This could be caused by an inherited DNA mutation or can occur due to several different environmental and chemical factors that lead to a mutation in DNA. Scientists have already begun to implement genetic engineering in clinical trials for cancer treatment. According to Deanna et al. (2006) there are three main types of gene therapy used to treat cancer cells: immunotherapy, oncolytic agents, and gene transfer. Immunotherapy involves genetically altering either a patient's cancer or bone marrow cells in order for the immune system to become better able to recognize and eliminate those cells that are cancerous. Oncolytic agents are genetically modified viruses that are essentially invisible to a patient's immune system. They are able to target cancer cells and signal them to enter cell death or apoptosis. Finally, gene transfer is the insertion of foreign DNA into a cancerous cell that also causes them to enter apoptosis.

According to Deanna et al. (2006), although not all of these methods are perfect, they provide promising results in some of the early human clinical trails in eliminating cancer cell growth.

Cancer is not the only potential medical application of genetic engineering. It also has potential to treat of HIV. According to Mohammed-Reza et al. (2017), different segments of the HIV virus genome can be cut by CRSIPR-Cas9 in order to limit its immunity to treatment as well as make it more visible to the immune system. While these trials on the HIV virus are generally new, they show promise.

Genetic engineering is also being applied to muscular dystrophy. So far Mohammed-Reza et al. (2017) reports that trials are limited to rats, however, using CRISPR-Cas9 scientists were able to remove faulty genes in the genomes of mice. This led to the production of necessary proteins for muscular growth and repair. The muscles grew back and achieved healthy status in the rats that were treated.

These are just a few of the potential medical applications of genetic engineering. Any medical disorder that is related to genetics could potentially be cured through this technology. The potential to find new treatments is virtually infinite. As we plunge further into the research of such technology, we will improve and perfect curing people of their affliction.

Enhancement Applications

Genetic Engineering is not only limited to medical use, however. This is where we get into what I believe is the unethical and irresponsible use of genetic engineering. While some will seek to cure, others will seek to fix what is not broken. The same technology that could save, could also push the physical and mental boundaries of the human body. With the enhancement of

humans via genetic engineering, comes much unforeseen consequence that must be accounted for.

It is my understanding that at this time humans are not currently being genetically enhanced. The technology is still in the animal testing phase. According to Gordon (1999), experiments have been performed on animals to enhance simple things such as muscle growth and overall organism growth. This, however, cannot be currently applied to humans as the side-effects cannot be accurately determined. Different organisms can respond to the alteration of their genomes in different ways. Hanna (2016) reveals that abnormally large mice known as Schwarzenegger mice have been created in laboratories. These mice have had their genomes altered so that their bodies grow more rapidly and overall larger. This experimentation is not limited to mice, however. According to Kota (2009) primates have also been genetically engineered to be become larger and stronger. After testing it was found that the primate's quadricep muscles as well as the legs were significantly stronger after genetic alteration.

Strength and size are not the only thing that have been enhanced in animals. According to Tang et al. (1999) mice have been genetically engineered to have significantly higher learning and memory capabilities. These mice were put through environmental tests after being subjected to genetic enhancements that increased the expression of a receptor known as the NMDA receptor. This receptor has been known to be associated with memory formation. Although these tests are only so far being applied to animals such as mice, they are proof of concept. If such enhancement can be applied to mice, they will certainly be progressed and eventually make it to human application.

Such enhancements could be the first genetic engineering on humans that does not involve solving a medical issue. I believe that once genetic engineering enhancements are

applied to humans, it is a downward spiral. Scientists backed by large companies will be funded to discover what genes control which traits, and be charged with finding a way to manipulate these genes. The practice of genetic enhancement on humans is a theoretical practice as of today, because of the uncertainty and risk of the procedures. It could be that people will begin to control every aspect of their bodies that they wish to change. It would be the new plastic surgery but on a deeper level. Enhancements could even be applied to germ line cells, those that alter the genetic makeup of offspring. Babies that are unborn could be altered to a parent's likings, without any input from the child itself. This in itself is a big controversy.

Where to draw the line

A distinction is necessary to draw between what is enhancement and what is medical therapy. Defining a medical intervention turns out to be an arduous task. To do so one must find a way to define those who are normal and those who are at a disadvantage because of their health. According to Mahowald (2006) the definition of what is medical intervention is not necessarily the same to everyone. Someone who cannot have a child at age twenty could potentially be fixed by medical genetic engineering, but someone who cannot have a child at age eighty may be able to have the same thing done. For the twenty-year-old, I believe it would be considered a medical application of genetic engineering, not enhancement, to fix infertility. This is because an average twenty-year-old should be able to reproduce given normal circumstances. Since generally people in their eighties are not fertile, it would be considered an enhancement to have such a procedure performed. Therefore, to figure out what is normal, the term health must be defined. According to the World Health Organization (2018), "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". This allows for an understanding of normal as one who lacks any inhibition, whether it be physical or

mental. As Colleton (2008) suggests, normal is a sort of average in society and, although a vague term, an average range is the closest one can come to defining what is normal. I, therefore, conclude that enhancement is defined as a treatment that brings a human being's health beyond what is capable of the average healthy human being. Enhancement is where the necessary procedures ends, and the optional procedures begins (Colleton, 2008). Before any genetic altering technology is available to the public, a sharper line must be drawn. Without specific definitions the technology's use will be left to interpretation.

Genetic Enhancement as Unethical

Now that some general terms and topics have been laid out, I would like to begin to pick apart genetic engineering used as an enhancing factor. It is my belief that this application of genetic engineering is not a wise use. Instead I see many consequences that will be brought forth if genetic enhancement is not regulated against.

Relations within the family

Genetic modification as a means of enhancement could pose potential issues to the family unit. Zinner (2006) suggests that a genetically engineered child could either be praised as a the most valued child in society or could be shunned by society as a non-natural beast. Either way it will have a negative effect. Just as discrimination has been a part of society since the beginning, nothing will stop the further discrimination either for or against genetically modified humans. It could be that society falls into the sort of scenario Dick (1968) suggests in *Do Androids Dream of Electric Sheep,* where those who are genetically engineered will not be treated as true humans, even though the are largely the same but better. Zinner (2006) also suggests that allowing parents to genetically enhance those that are unborn to suit their desires can create the mentality that

children are more of a commodity. Although this is not a common view of society today, being able to create an enhanced child built to order may change this. I believe the mindset of having a child would change. Children could become a style, a signifier of status more so than the intimate thing they are today.

There is also the issue of the pressure put on a child to perform if a parent decided to genetical enhance their offspring. According to Sandel (2004) Some may say that there is no difference between a parent sending their child to the top educational institution in the area and genetically altering them to be better suited for success. To a certain extent this may be true. However, this argument is superficial. A parent who spends resources to genetically enhance a child to perform better than all the other children will expect results. If a child does not perform to these standards then a parent may become disappointed in the child, yet it is not the child at fault. There is already so much pressure on children from their parents to perform well. Genetic enhancement is bound make this pressure exponentially higher. Sandel (2004) suggests that this is much like the case of a sporty parent who pushes their child to be the absolute best player on all their athletic teams. If that parents puts a lot of time, effort, and money into a child's practice at a specific sport, then there is a lot of pressure on that child to do well.

Threat to Autonomous Living

Another ethical concern for the genetic enhancement of humans is the risk of compromising a person's ability to think of themselves autonomously. As Mameli (2007) describes, one who is not totally in control of where they came from, may not be able to fully accept their actions. Someone who was designed by their parents or elsewhere may place blame on those who gave them certain traits, instead of assuming control of their own lives. This could lead to a potential issue in the moral responsibility of those who are genetically modified. They

may not place blame for anything they do on themselves, but on their parents. Maybe it is true that this blame is properly placed on their parents, but it still poses a threat to the status quo of society. In my eyes this is dangerous. Genetically enhancing somebody could lead to unintended emotional consequence in those who had no voice in how they were conceived or designed. Those that lack a sense of self-accountability could be a danger to society.

Buchanana et al. (2000) raises the point that those who are genetically enhanced by their parents do not necessarily to have the opportunity to live their own lives according to how they would like to live it. Certain traits enhanced by parents to enhance may predispose a child to pursue a specific career, thus eliminated a child's ability to make their own life decisions about what kind of life they wish to lead. Genetically modified humans, therefore, are not free to do what they wish. To me this is a violation of fundamental human rights. Everyone should have the choice of how they want to live their life and what they wish to pursue. This is the same sort of idea that Huxely (1932) presents in the society of *Brave New World.* Those that occupy this society do not choose what they do, rather are engineered to fulfill a specific task in society. Everyone has their role and must stick to it. This is something I fear. Genetic engineering used as an enhancement could eventually lead to a society living in tunnel vision.

Social inequality

Society today already sees great inequality amongst the people that inhabit it. While some are to able to afford the nicest clothes and amenities, others are left begging for food. Genetic enhancement is not something that would be available to all. The gap that already divides society could become an abys that no one could escape. Sandel (2004) suggests that those social classes who can afford the enhancement, and the normal poor humans who cannot, may end up

becoming two new subspecies. Those who are enhanced could take all the major roles in society, while those considered normal would fill in the cracks and be chained to the bottom of society.

Some such as Bercic (2016) argue that there is no one gene that can determine the success of a person and, therefore, genetic engineering will not bring such inequalities, I argue against this. While scientists have not discerned whether one gene can determine the success of a person, according to the National Institute of Health (2018) certain traits such as intelligence, that are vital to one's performance in life, can be linked to genetics, and, thus could be enhanced. Higher intelligence tends to correlate with success.

Bostrom (2003) offers the counter argument that the government could subsidize such enhancements to make them more available to the public, but I see a major flaw in this. While some may choose to enhance themselves and their children, there will always be those who choose not to mess with the genetic makeup of themselves or others. Avoiding this source of inequality would require either harsh restriction or requirements for genetic engineering. Either way I do not believe such law would be widely embraced by society.

The Imperfect Endeavor for Perfection

It must be noted that humans can never become a perfect being. What is considered perfect now may not be considered perfect in the following years or even the following months. Human beings are ever changing creatures who constantly change their perceptions of the world around them. I believe this raises a major issue with genetic enhancement. There will always be a raising bar. Soon enough genetic enhancement will have gone so far that humans will no longer be humans. Silver (1997) suggests that genetic engineering will enter us into a race that no one finishes. A race that will be pursued by individuals and not society as a collective unit. Parents

will constantly be trying to genetically enhance their children to become the perfect little humans, better than all of their peers. However, if the definition of a perfect person is always changing, people will never be good enough. They will have to dive deeper into genetic enhancement and enter a vicious cycle of imperfection. Some could argue that this would push society to continue to enhance and better human beings, but once again we enter the issue of those who will be left behind with the genetics granted to them by natural processes.

Medical Genetic Therapy as Ethical

There is an ethical code that all doctors must swear to follow before they are allowed to openly practice medicine. According to the American Medical Association (2018) doctors must provide the necessary care for those who are need of it. If there is a potential for finding cures for those with necessity through genetic engineering, I feel it is the responsibility of doctors to use such tools. There are many diseases out there, such a cystic fibrosis and thalassemia (a blood disorder) that currently have no cure. Those who are found to possess these illnesses are doomed to live their lives at the mercy of their handicaps, or perish. I see no reason to stop the development of a technology that could potentially give people new lives and new opportunities.

Ask anyone you know that if there is a chance cancer would be cured and millions of lives could be saved, if they would use genetic engineering to do so. I do not know many, if any at all that would say they would not try to find the cure. According to the National Cancer institute (2017), in 2012 there were 8.2 million cancer related deaths worldwide, and this statistic is set to rise to 22 million in the following decades. That is, if we do not find a way to cure this vicious disease.

Some choose to argue that introducing genetic engineering into the medical field brings forth too much risk. Manipulating genetic sequences could have unintended consequences (Patra & Andrew, 2015). Changing one gene could lead to a cascade of events that were unanticipated and cause an undesirable affect. Although a vague solution to this problem, like other medical practices that have been developed, extensive testing in laboratories must be conducted and come to conclusive evidence that these sorts of issues are worked out. This may take a long time, but the benefits that will come out of this research greatly outweighs the cost.

The New Wave of Eugenics

Eugenics is an effort to make an artificial change to a gene pool either in a positive or negative way. This term was invented by Francis Galton, a scientist who mainly focused on the topic of inheritance (Gillham, 2001). Genetic engineering, therefore, is inherently a type of eugenics. Positive eugenics are promoting genes that are desirable. Negative eugenics are getting rid of genes that are not desirable. Generally, genetic enhancement would fall under positive eugenics and genetic therapy would fall under negative eugenics. Genetic engineering, therefore, is a very slippery slope into a new age of eugenics, whether intentional or not. According to Ko (2016) the United States was engaged in a eugenics movement throughout the twentieth century through means of sterilization laws. Once the Nazi regime began their quest to create the Aryan race using government sponsored eugenics, the United States decided to deme this unethical. However, the United States and other countries that decide to pursue genetic engineering will face a new ethical question of whether the inherent eugenics that come with genetic engineering are okay.

It is my belief that this new eugenics wave is not the same as what has previously been conducted. Whereas in previous eugenics movements we saw group sponsored and pursued

eugenics, this wave will be more so pursued by the individual. This may add a new layer to the conversation. While I argue that genetic enhancement is unethical, that does not imply I think all eugenics are inherently bad. As Mahowald (2006) suggests, there may be such things as good and bad eugenics. Good meaning it is commendable and bad meaning it is vile. It is my belief that the use of genetic engineering to enhance is an example of bad eugenics. It creates exclusivity in society and promotes certain traits to be more desirable. Genetic engineering used as a medical therapy, however, I view as good eugenics. It does not create this sense of one specific trait being better than the other but attempts to place everyone on a level playing field.

Previously seen eugenics sought to prevent the production or exterminate humans that were seen as unfit for society. Genetic engineering used as medical therapy is not the same. It seeks not to prevent life, but to promote life. Through genetic engineering as a medical tool, people who previously may have lived shortened or handicapped lives will cease to exist. Genetic engineering used in medicine may force the need for a change in the connotation of eugenics. However, used as enhancement, genetic engineering plays the same role in eugenics that we have seen throughout history.

Regulation Proposals

Potentially being able to play God through genetic engineering seems to be a dangerous power that I believe must be regulated. It is never too soon to begin regulation discussions and debate to prepare the world for what is coming. The issue has already been a revolving topic within the National Institute for Health. LeRoy Walters, the former head of the Recombinant DNA advisory committee, weighed in on the subject on multiple occasions (Mahowald, 2006). He aired on the side of caution when it came to genetic enhancement but was easier on the issue

of genetic therapy in medicine. This topic, however, must be pushed onto the agenda and held with high priority.

According to Cornetta (2003) the regulation of genetic engineering is very fragmented amongst many different organizations. I see this as problematic. The regulatory responsibility of deciding where to draw the line on genetic engineering should be left with one group. This group should be specifically tasked with the job. Too many conflicting interests could have an effect on the efficacy of a decision-making body.

I hold true to my belief in the unethical aspect of genetic enhancement. Therefore, I do believe that the scientific communities and governments should decide to put extreme restraint on this use of the technology. The consequences genetic enhancement could have on society could be devastating given time. The results of such procedures are too unpredictable and will alter society as we know it.

While I do see the medical application of genetic engineering as a beneficial addition to the medical community's arsenal of tools, I also believe this must be tightly regulated. Genetic enhancement and genetic therapy are very close in definition. Too much freedom in genetic medical therapy and it could slip into genetic enhancement. I believe that to prevent such a slip form happening, genetic medical intervention should only be used when the quality of life is dramatically changed when a procedure is performed or more importantly in the case of a life-threatening condition.

Before any procedures for any use are to come out it is also necessary to regulate the testing. Safety is the number one priority. Genetics offer many chances for unintended consequences. Changing one gene could have ten different physical responses in the body that

are not accounted for. To ensure the safety of those who are to be exposed to such procedures, extensive testing with strict guidelines must be conducted

Conclusion

Whether or not I agree with it, genetic engineering is certainly an inevitable future technology. Rana, Marcus, and Fan (2018) reveal that China is already introducing gene therapy treatments to cancer patients in their hospitals. This technology may be coming sooner than anticipated. I fear this. Just like in Gibson's (1984) *Neuromancer,* our society is not advancing fast enough for the technology we are creating. We have not decided what is ethical and where to draw the line, yet we are integrating these technologies into society.

Genetic Engineering is pushing boundaries and making us rethink what it means to be human (Fukuyama, 2002). Genetic Enhancement will most certainly pull us away from being human and begin the posthuman era. Medical genetic therapy will preserve the humanity we have now. I can only hope that the ethical concerns I brought up are enough to deter anyone from the thought of allowing genetic enhancement, however, I am not naïve enough to believe that people will not find ways to bring genetic enhancement into society. This essay serves as a warning to those who seek to follow through with genetic enhancements. There are many deep consequences that may not be observed by those who are not vigilant. Genetic enhancement is not ethically correct and carries much luggage along with it. The world is certainly on the brink of a major change.

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