The Appalachian Dilemma: An Ethical Debate on Genetic Therapy and Genetic Enhancement

Haley M. Sizemore
Eastern Kentucky University, haley_sizemore11@mymail.eku.edu

Eastern Kentucky University

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By

Haley Sizemore

Mentor

Dr. Laura Newhart

Department of Philosophy

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Haley Sizemore

Dr. Laura Newhart

Department of Philosophy

Abstract: Over the past century, advances in biomedical technologies have resulted in a need for government regulation of the distribution of genetic modification and medical enhancements. Without these regulations, the poor of Appalachia will suffer immensely from the lack of protection against genetic diseases, and disorders, and lack of opportunity for genetic enhancements, and will eventually fall further behind more developed and wealthy areas regarding their health and quality of life. She suggests that government regulations such as implementing systems focused around utilitarianism, prioritarianism, and equality could help to reverse this effect of poverty and unequal distribution of health.

Keywords and phrases: genetic enhancement, genetic therapy, CRISPR Cas-9. gene editing, biomedical ethics, genetic modification, designer babies

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In the past century, advances in biomedical technologies have increased exponentially and are projected to maintain that trend in the future. With any new technology comes new issues that have to be resolved. For example, genetic engineering of crops has the potential to increase agricultural productivity, however, it poses very serious environmental risks that must be considered (Altieri, 2000). In the same way, biomedical technology brings with it new medical procedures, and with new medical procedures comes a great deal of biomedical ethical disputes that then spread throughout the biotechnical and biomedical communities. One highly debated matter within the biomedical community surrounds the just distribution of healthcare.

In America, this matter centers itself around the impoverished of the country—or those who cannot pay for medical services as readily as the wealthier classes. Appalachia is known for many things, a few being the lack of education and the abundance of poverty within the region over a very long span of time. Therefore, this lack of wealth results in an absence of proper health care. Appalachia falls behind in many rankings. "In [Appalachian settlements], in which virtually everyone [is] at risk of poor health outcomes…" individuals wonder why some families have incredibly sick children and other do not. It boils down to the wealth and education of the parents of those children (Erwin, 2008).

With new biomedical technologies and procedures, the ability to prevent genetic diseases and disorders and genetically enhance offspring has become possible (Sankar, 2015). With the effects of poverty in Appalachia, the ability for individuals to receive this treatment would be minimal if treatment is given only to those who have the means to pay for it on their own without the help of health insurance coverage. Government regulations such as implementing systems focused around utilitarianism, prioritarianism, and equality could help to reverse this effect of poverty with the just distribution of health

care, but the principles of biomedical ethics must contribute to the making of any policies or allocation system. Otherwise, the three ethical topics must all promote each other equally which can only happen in certain situations. Without proper ethical policy to regulate the usage and distribution of new genetic biomedical technologies, the poor of Appalachia will suffer immensely from the lack of protection against genetic diseases and the lack of opportunity for enhancements past a basic healthcare need.

The CRISPR-Cas9 System: A Solution

Thanks to biomedical technology and advances in biomedical sciences, it is commonly known that every cell in the human body has a copy of that individual's genome. Advances in genetic sequencing have allowed researchers to make connections between the genome and a variety of diseases. After learning the major effect of the genome on a person's health, scientists began looking for ways to safely alter the genome as a solution to these diseases. Although other solutions have been discovered, the CRISPR-Cas9 system is the most inexpensive, effective, and therefore the most efficient method of altering the genome. Jeffry D. Sander and J. Keith Joung claim that even though

"the genome-wide specificities of CRISPR-Cas9 systems remain to be fully defined, the capabilities of these systems to perform targeted, highly efficient alterations of genome sequence and gene expression will undoubtedly transform biological research and spur the development of novel molecular therapeutics for human disease" (Sander, 2014). The biomedical technology presents the ability to engineer biological systems and organisms and this has enormous potential for applications across science, medicine, and biotechnology (Ran, 2013). CRISPR technology, or clustered regularly interspaced short palindromic repeat, is an adaptable immune mechanism that is used in nature by bacteria to protect itself from viral infections and from plasmids, meaning it is not "new" technology in the sense, but is being applied in a new way. The development of this recombinant DNA technology began in the 1970's, but recent advances in the technologies have begun a sort of biotechnological revolution (Hsu, 2014).

How Does It Work?

What is the CRISPR-Cas9 system and what does it actually do? Simply, it can remove one piece of DNA and replace it with another piece. For example, if someone has a gene that makes them more susceptible to a certain

disease, the CRISPR-Cas9 system could cut that piece of DNA out of the genome, and insert a new and healthy gene in its place. Within the cell, the system is not much more complex. Clustered regularly interspaced short palindromic repeats or CRISPR, CRISPR Associated genes (Cas) and the Cas protein (Cas9) are the main factors in this technology (Scherz, 2017).

To begin, the use of CRIPSR-Cas9 in nature must be discussed, and that involves the defense mechanism used by bacteria to protect itself against viral infection. To infect bacteria, viruses inject their DNA into the bacteria. To defend themselves from viral infection, bacteria use the CRISPR-Cas9 system to cut the viral deoxyribonucleic acid or DNA and hinder it mutated or nonfunctioning. The bacteria capture segments of DNA from invading viruses and use the sequences to create the DNA segments that are between the regularly-interspaced short palindromic repeats in CRISPR. The sequences used to identify viruses is a sort of archive of past attacks and is used to protect against attacks by those viruses again. Cas9, a CRISPR associated gene protein, is transcribed when virus DNA is detected, and it is an enzyme that acts as a pair of molecular scissors. This protein is targeted by guide ribonucleic acid or gRNA, also known as crRNA or

CRISPR RNA, and it then binds to the gRNA or crRNA that is produced from the CRISPR segments making the CRISPR-Cas9 complex. The gRNA or crRNA binds to Cas9 and to the specific sequence in the DNA that has been selected for editing. The gRNA or crRNA has RNA bases that are complementary, by Wilson and Crick standards, to the bases of the target DNA sequence. The Virus DNA binds to the target sequence within the complex, and the DNA is pulled apart. Although the specific sequence within these crRNAs that targets DNA normally pairs to viral DNA, which is the natural mechanism for CRISPR-Cas9 antiviral defense in bacteria, the sequence can very easily be replaced by a sequence of interest to alter a specific piece of the genome. Then, Cas9 cuts the gene so that it is free from the rest of the sequence of DNA. When the two pieces of DNA are released, they try to come back together and mutations occur, disabling the gene altogether. Once the DNA is cut, researchers can use the cell's own DNA repair machinery to add or delete pieces of genetic material, or replace the gene with a customized piece of DNA. (Reis, et. al, 2014).

How will this be applied in healthcare treatments?

The clinical application of this technology has a few specificities. Treatment with the CRISPR-Cas9 therapy comes

in different forms. In most applications, the genetically modified cells are injected into the patient. The patient could either be an embryo still in development or could be a living individual. The injection could either effect the somatic cells of the patient, which would alter their genome in a way that was not then passed down to the patient's offspring. On the other hand, the patient could be treated as an embryo or treated for cells that affect the reproductive organs of that individual, referred to as germline genome editing (Nicol, 2017). These new genetic modifications would be passed on to that individual's offspring.

Main Biomedical Ethical Issues

Although there are numerous biomedical ethical issues that need to be confronted, one of the most significant as of recent surrounds genetic modification technology. Eric Juengst's "Crowdsourcing the Moral Limits of Human Gene Editing?" confronts one of the most well-known and hot-button ethical dilemmas of genetic modification. The dilemma is the ethical implications of "two kinds of potential gene-editing experiments in humans: those making inheritable germ-line modifications and those designed to enhance human traits beyond what is necessary for health

and healing" (Juengst, 2017). These two genetic modifications must be defined.

Somatic vs. Germline

The genetic modifications that are "making inheritable germ-line modifications" must be compared to the genetic modifications that do not (Jeungst). In the same way, genetic modification that is "designed to enhance human traits beyond what is necessary for health and healing" must be compared to genetic modification that is designed to treat for the patient's health and healing.

Somatic-cell genetic enhancement includes genetic modification that introduces new, modified cells to nonreproductive cells. This would prevent them from being passed down to future generations. Germ-line genetic enhancement includes the introduction of genetically modified cells into reproductive cells, including the sperm, ova, or preimplantation embryos. The changes would then result in an alteration that is then passed down in the genome. (Degrazia, et.al, 2011)

Therapy vs. Enhancement

Therapeutic genetic engineering, commonly called "genetic therapy," includes interventions that are directed

at the cure of genetic disease. Nontherapeutic genetic engineering, or "genetic enhancement," includes interventions directed towards the alteration and enhancement of human traits and capabilities such as height, strength, or intelligence. (Degrazia)

Current Ethical Policy

United States

Erwin dissects a consensus made by the United States' National Academies of Science, Engineering, and Medicine (NASEM) in 2017 that can be described as 'opening the door' to the ethical conversation regarding genetic modification. In the end, they decided it was critical to allow diverse public input and voice in the policy-making process regarding the framework for ethical decision making in genetic enhancements and modification. Although this is a start to the discussion of biomedical ethical policy, still no actual action was taken to create a policy surrounding this major dilemma. It is imperative that this is one of the first ethical issues that has policy to regulate it.

United Kingdom

In the United Kingdom, the Nuffield Council on Bioethics published a report of the ethical and social

implications raised by heritable genetic and genome editing treatments. They came to the conclusion in July of 2018 that the use of genetic modification could be morally permissible in some circumstances. The recommendation given by the counsel was as follows:

> "Any use of genome editing interventions should be guided by two overarching principles: they must be intended to secure, and be consistent with, the welfare of the future person; and they should not increase disadvantage, discrimination, or division in society. More work needs to be done to establish whether these principles can be met. (Nuffield Council on Bioethics, 2018)."

The council began to work on their report in September of 2016.

China

On the other hand, Chinese geneticists' views of ethical issues are much different than that of geneticist in both America and the United Kingdom. China has made genetics a priority for decades. In the 1960's, cytogenetics technology was introduced, and then in the 1970's, chronic villi sampling was performed (Mao). Now, reports have been made that a successful genetic

modification on an embryo has been performed in China. Because of the cultural difference between the UK and America, and China, China has already begun very serious human trial research.

What will the insurance pay for?

According to the U.S. National Library of Medicine, health insurance plans in many cases will cover the costs of genetic testing when recommended or suggested by the person's physician. Most insurance companies today will pay for at least some genetic counseling and genetic testing. An example of this is that under the Affordable Care Act, both genetic counseling and BRCA gene testing in females (a gene associated with breast cancer) is covered. There are differences in policies per provider when it comes down to which tests are covered, and many individuals opt out of having their insurance company paying for genetic testing. This is due to the fact that genetic tests can result in a person's insurance coverage being effected.

However, the issue of insurance companies covering the costs of genetic modification is a different story. In the United States, there has been little-to-no discussion on the topic of coverage regarding genetic modification. In other countries, like the United Kingdom, there is at least

some discussion happening. However, in the United Kingdom, the discussion on insurance policy regarding genetic modification is focused mainly on the coverage issues regarding genetically modified products instead of the issues regarding the genetic modification of humans (James). Most likely, insurance companies will cover the cost of genetic modification for therapy and not enhancement. This aligns well with previous ethical and insurance policy decisions of the United States regarding the personal payment for cosmetic treatment that does not directly affect the person's health, and the coverage of procedures directly related to health benefits. If someone decided to get facial reconstruction surgery because their cheekbones were too low for their liking, insurance would not pay for that procedure. In the same way, if a parent would like their child to be above-average in height, the funding for this genetic modification for enhancement would have to come out of their pocket and their insurance provider would not help cover the cost. On the other hand, if someone has a broken arm, their insurance provider would help cover the cost of the treatment for that patient. In the same way, if a parent had their future child's genome sequences and was informed that they may have a genetic

disease, the insurance would help cover the cost for the genetic modification for therapy in that instance.

How does this effect the impoverished of Appalachia?

If insurance companies in the United States follow by this precedent and genetic therapy is covered by insurance companies country-wide, Appalachians with health insurance will be able to benefit from the health-related aspects of the CRISPR-Cas9 system. However, the other modifications that are for the purpose of enhancement will be costly and will come out-of-pocket from expecting parents who would like to genetically enhance their child. Therefore, only wealthy individuals will have the ability to genetically enhance and design their children. Because of this, it is very likely that the poor of Appalachia will fall behind in things such as scholastics and athletics, because wealthier areas of the country would be able to afford genetic enhancement for the benefit of greater intelligence and physicality.

Additionally, the religious backbone of Appalachia may affect how parents feel about genetic modification. As more and more technology is discovered, there are more and more ways that parents can then neglect their children by withholding certain technologies from them(Hammond, 2010).

Hammond argues that in a range of cases, parents will have a moral obligation to use genetic treatments to prevent serious disabilities. However, this presents an issue if the parents cannot pay for this treatment.

Ethical Stances Regarding Genetic Modification

Thomas H. Murray

Thomas H. Murray's "Stirring the 'Designer Baby' Pot" also ventures into the ethical dilemmas surrounding genetic manipulation for health and wellness versus genetic manipulation for enhancing traits that will not affect health whatsoever. He concludes that the ethical discussions about genetic manipulation cannot be postponed forever. He adds that in the future, "it would be a great public serve to provide a sober assessment of the choices that would-be parents increasingly face, and to encourage respectful dialogue about the meaning of parenthood and the worth of a child so that the parent and children can flourish together (Murray, 2014). This would help to prevent parents from making decisions like having genetic testing done for any other reason than for the best interest of the child. Still, no policy has been made regarding the allowance or distribution of modification or enhancement. However, trivial things like sex-selection are

still controversial and are debated on whether they are ethical or not. Regardless, "legislation, regulation, and professional guidelines depend on widely shared public values and their legitimacy" (Murray). The public will have to decide what their priorities are regarding the genetic modification of future generations.

David Resnik and Daniel Vorhaus

Some views on genetic modification are strictly for or against the technology. David Resnik and Daniel Vorhaus break down the authenticity argument, uniqueness argument, freedom argument, and the giftedness argument and explain how each are unsound. They do so by explaining that each of these popular arguments assume a strong genetic determinism. Determinism is "usually equated with the problem of free will: we are compelled to make the choices that we make as a result of previous circumstances, and cannot make choices that are genuinely free." Genetic determinism is defined as the view that genes cause traits. They argue this definition is not precise enough and therefore causes the other arguments against genetic modification to be false.

Michael J. Sandel

In Michael J. Sandel's "The Case Against Perfection: What's Wrong with Designer Children, Bionic Athletes, and Genetic Engineering," he argues that new breakthroughs in genetics present humanity with both a "problem and a predicament" (Sandel). The promise, he explains, is that someday there will be a way to prevent or cure a multitude of genetic diseases, and the predicament is the knowledge that genetic modification for purposes of advancing persons is possible with these newfound genetic technologies. Sandel concludes that the reason genetic modification makes individuals uneasy is because genetic manipulation threatens to eliminate mankind's appreciation of life as what he says can only be described as a gift, and to leave "us with nothing to affirm… outside our own will" (Sandel).

First, according to Sandel, there are four major areas that genetic manipulation would be used: muscles, memory, height, and sex selection. Other ethicists have approached genetic modification in a similar way. With each, he explains why it would be modified, what some claim is the reason for people's unease, and a rebuttal as to why that is not the case. For example, Sandel describes reasons that gene therapy would be readily encouraged and accepted for

degenerative muscle diseases. However, when it comes to improving the musculature of unborn children, this could bring some concern to many individuals. “Why?” he asks. Many people explain their discomfort with the idea of improving or enhancing the muscle mass of embryos because they would grow into genetically enhanced athletes that would have a genetic advantage over other (non-genetically modified) individuals. They feel as if it would be unfair to persons who were not genetically enhanced prior to being born. Sandel rebuttals this claim by asserting that there is a fundamental flaw in that argument. He argues many successful athletes have natural genetic advantage over others by luck of the genetic draw. Some are naturally taller, have greater muscle mass, and were born with traits that allow them to be exemplary athletes. Consequently, he Sandel concludes people’s unease with genetic enhancement cannot stem from feelings of unfairness to those who are not genetically altered.

He continues discussing each of the other three major areas for manipulation, describing how each causes unease but cannot be explained away by what most individuals would claim causes them to be uncomfortable with the idea of the manipulation. In regard to memory, he says that people are concerned that it would generate an unequal distribution of

enhancement, creating what could be considered two races of people. He claims that this argument is invalid because it ignores the moral question at hand: would the enhancement of certain persons' memory dehumanize them, or would the poorer community of people that were not enhanced be put at an unfair disadvantage? The arguments are then similar in both height and sex selection: the claims of unease do not come from where most people assume. It must come from somewhere deeper than what it seems to on the surface.

His conclusion is that this unease is sourced from the threat to our appreciation of life as something persons were given, not something that was controlled, and then 'because of this newfound control, persons would be left with nothing to affirm or behold that was any further than their own freewill.

The Principles of Biomedical Ethics

The importance of biomedical ethics must be explored in order to begin to delve into the moral implications of genetic modification. Biomedical ethics must be involved in any scientific decision in order to regulate proceedings and protect individuals involved. Marcia Miki Sato's "The influences of different socioeconomic scenarios in bioinformatics and biotechnology: The ethical issues

arising from technological advances," marries bioinformatics and biotechnology to convey the importance of biomedical ethics within the two fields. She begins by explaining how that ethics in science becomes a complex issue, arguing that "Ethics should not be segregated into different fields as it assumes ideas of boundaries and stable values. However, science and society values are in constant transformations, which hinders the imposition of ethical values to science" (Sato, 2016).

She analyzes the public, private, and academic spheres in various situations regarding agriculture, genetic modification, genetic information, and biological research and addresses similar case studies of genetic information and explores how they were handled. Consistently, she supports the idea that "Ethics should not create obstacles to the scientific development, but to ensure that moral values are not deteriorated" (Sato). Biomedical ethics are to enhance the proceedings of scientific developments, helping each of them to be as successful as they can be while putting the least amount of risk on individuals or their surroundings. In the end, she concludes that "there is no binary way to answer bioethical issues" (Sato), but without an analysis of the consequences of the advances in biotechnology, the "essence of being human" (Sato) is at

risk. Although it would be easiest if biomedical ethical principles gave us straight forward answers, the decisions made regarding regulation and policy will most always be complex. However, the ethical decisions must be made in order to preserve our humanity. For this reason, a clear, concise, biomedical ethical policy regarding genetic modification is imperative.

It is appropriate to explore the principles of biomedical ethics to use as a guide for the construction of government regulations for the equal and fair distribution of genetic modification and manipulation with CRISPR-Cas9. The four principles, each of which being conditional, are as follows:

1. The principle of respect for autonomy; this enforces the notion that medical professionals should not hinder the proficient implementation of the autonomy of the patient. Autonomy refers to a person's ability to make their own choices in their lives, acting with stringency and self-will in their judgements. Another term for autonomy is "self-rule." The ability of a person to be able to give their own medical consent has many qualifications—all of which could be strongly associated with the patient's competency. If one cannot give consent, the patient's

living will is consulted, or if there is no living will (especially in the case of genetically modified embryos) the surrogate decision maker is consulted (in the case of embryos, the parents).

2. The principle of non-maleficence; this enforces the notion that medical professionals should not act in ways that would cause harm or discomfort to patients. The distinction between non-maleficence and the following principle is that non-maleficence can be met by doing nothing. An example of non-maleficence would be to not kill or cause unnecessary and unbeneficial pain.

3. The principle of beneficence; this enforces the notion that medical professionals should act in ways that will benefit the wellbeing and health of the patient. This principle is different from non-maleficence in that it requires action on the part of the participant.

4. The principle of justice; this enforces the notion that health care and how that health care is payed for should be distributed in accordance with the demands of justice. (Degrazia, et.al, 2011)

These four principles should be used to shape the allocations for the just distribution of genetic

modification and manipulation along with the three ethical principles of prioritarianism, utilitarianism, and equality to create the fairest policy for all people. In using these principles in accordance with each other, any question of importance in each of them could be resolved quickly and effectively. Previously, it was stated that each of the principles are conditional and this stands true. One principle may out-weigh another in one situation and be equally important in another. This flexibility and adaptability allows for the specificity of each case as it presents itself.

Other Ethical Principles

The four principles of biomedical ethics can be used to shape the allocations for the just distribution of genetic modification and manipulation if paired with the three ethical principles of prioritarianism, utilitarianism, and equality. This would allow for the creation of the fairest policy for all individuals. In using these principles in accordance with each other, any question of importance in each of them could be resolved quickly and effectively. Previously, it was stated that each of the principles are conditional and this stands true. One principle may out-weigh another in one situation

and be equally important in another. This flexibility and adaptability allows for the specificity of each case as it presents itself.

Prioritarianism

The first, prioritarianism, is one of the moral principles that individuals argue is what must be followed to make fair and easy government regulations and allocations for the just distribution of treatments surrounding genetic manipulation and modification. Prioritarianism is a principle adjoining the ideas of favoring or having a preference for the individuals who are considered to be the worst-off. Examples of this would be to prioritize the sickest first which "aids those who are suffering right now; appeals to the 'rule of rescue'" (Persad 260). Therefore, if someone from Appalachia was worse-off than someone in a wealthier area, the offspring in Appalachia would be taken care of first because of the beneficence and justice principles. This would help to distribute care ethically regardless of the economic status of the parents.

However, some argue that the sickest people are the worst-off and therefore may benefit the least from treatment. For example, if someone had stage 4 cancer,

treating them may not be considered as ethical as treating a baby who has a better chance of surviving for a longer period of time. However, this is not the case with genetic modification. The sickest people in genetic modification are the offspring with the most genetic diseases or disabilities. If genetic modification is perfected, the sickest will benefit the most in this circumstance. The sickest would be individuals with fatal genetic diseases that would exterminate them either before they were born or soon afterwards.

Additionally, by using the principles of biomedical ethics as a guide, the principle of beneficence enforces the notion that the medical professionals should help the sickest first in genetic situations because it will benefit the wellbeing and health of the patient.

Utilitarianism

To continue, utilitarianism is another of the moral principles that individuals argue is what must be followed in order to construct fair and simple government regulations and allocations for the just distribution of treatments surrounding genetic manipulation and modification. Utilitarianism is a principle surrounding the

ideas of maximizing the total benefits for all people. Examples of this would be to focus incentives on saving as many lives as possible which "[benefits] the greatest number; avoids the need for comparative judgements about quality or other aspects of lives" (Persad 260) and to focus incentives on "prognosis or life-years saved…[which]... maximizes life-years produced" (Persad 260).

Conversely, others argue that implementing an incentive that promotes saving as many lives as possible is "insufficient on its own" (Persad 269). If this principle is part of a larger group of incentives, including promoting the treatment of the sickest first, more people would be saved in a more ethical and just manner: infants who would have died before birth could live, while infants who would have lived to old age but gotten osteoporosis may not be put first on the list for service. In the same way, offspring that would be born with a genetic disease would be treated before another offspring that would be born with below-average height.

Even others maintain that executing a motivation that promotes increasing life-years ignores the issue of distribution and quantity. As stated beforehand however, if this principle is part of a larger group of incentives,

including promoting the treatment of the sickest and worst-off first, and promoting the saving of the most lives, more people would be treated appropriately according to the principles biomedical ethics. Justice, non-maleficence, and beneficence are all maintained in these circumstances.

Equality

Finally, equality is one of the moral principles that individuals argue is what must be followed to create reasonable and simple government regulations and allocations for the evenhanded distribution of treatments surrounding genetic manipulation and modification. Equality is a principle surrounding the idea of treating all individuals alike, and placing everyone on level ground. An example of this would be to implement a lottery system where little information is needed about patients and any corruption is minimized in the system.

Some argue that the lottery is blind to relevant factors. For example, "random decisions between someone who can gain 40 years and someone who can gain only 4 months" (Persad 267) are not appropriate decisions to make by lottery. Response: Again, if this principle is part of a larger group of incentives, including promoting the treatment of the sickest first, promoting the saving of the

most lives, and promoting the increasing of live-years, more people would be saved in a more efficient and fair manner.

Still, these are all situations in which all three principles, prioritarianism, utilitarianism, and equality all work together and promote each other. But what about in situations where they do not? What happens when two of the three conflict? One must look to the principles of biomedical ethics. Each of the four principles of biomedical ethics, respect for autonomy, beneficence, non-maleficence, and justice can all act together as guides for what to do in each specific circumstance.

For example, what would happen if all the parents of the offspring needing genetic modification were put into a lottery? The individuals chosen would not necessarily be the sickest or the worst-off. The individual may also not be in as severe a case as another embryo. Therefore, the principles of biomedical ethics would have to be in place in the lottery. It would somehow have to be separated by the sickest or worst-off, so the beneficence and non-maleficence principles are included. In another example, there may be two equally bad cases of genetic disease. The order of treatment would have to be determined in another way other than promoting the life years or lives saved.

This is when a lottery could be used, to maintain the justice principle of biomedical ethics. This allows the distribution of care to be just, as it was randomly assigned by lottery so both cases had an equal chance of being treated first.

All of this leads back to the beginning point, that without these principles, the poor of Appalachia would be left behind. Instead of the wealthiest of people enhancing their children to be taller, smarter, and more talented, only the sickest or worst-off of embryo would be treated in order of severity, not willingness or ability to pay.

Conclusions

Recent advances in biomedical technology have increased exponentially and therefore, great deal of ethical disputes that have introduced themselves into the scientific and medical communities. The just distribution of health care is still a highly-contested topic in the ethical and medical fields. In America, this problem infests the impoverished of the country.

The lack of wealth in Appalachia results in an absence of proper health care for the citizens existing there. Government regulations such as implementing systems focused around utilitarianism, prioritarianism, and equality could

help to reverse this effect of poverty with the just distribution of genetic modification and manipulation, but the principles of biomedical ethics must contribute to the making of any policies or allocation system. Without the principles of respect for autonomy, beneficence, non-maleficence, and justice, the three ethical principles previously stated cannot stand.

In conclusion, government regulation or policy must be instated for the protection of all persons, including the underserved and impoverished of Appalachia. The lack of wealth in Appalachia results in an absence of proper healthcare for the citizens existing there. Government regulations such as implementing the principles of biomedical ethics must come to fruition sooner than later.

Finally, without government regulation of the distribution of genetic modification and medical enhancements, the underprivileged of Appalachia will suffer immeasurably from the absence of protection against genetic ailments and disorders and absence of opportunity for genetic improvements and will eventually fall further behind more developed and wealthy areas concerning their health and quality of life.

Fortunately, great advances in science will continue to occur far into the future. Unfortunately, these advances

will be accompanied by new ethical problems that must be solved for the wellbeing of all persons. A great deal of ethical disputes that have introduced themselves into the scientific and medical communities will be followed by new ethical dilemmas. However, if policy can be instated now, it can act as a precedent for future policy, making the process to protect underserved persons and their surroundings much more efficient.

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