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Arguments for Treating CRISPR-Edited Persons as Vulnerable

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Abstract

This paper is composed of four parts. In the first part is briefly described the origin of germline genome editing technology and its unique characteristics. The second part discusses germline genome editing is ethically unjustifiable today because of the unfavorable risk-benefit ratio. The third part argues that CRISPR-edited persons ought to be treated as a vulnerable. The fourth part is to argue that people in the present generation have moral obligations to future generations.

Keywords: Gene Editing; Germline Cell Genome; Risk-Benefit Ratio; Vulnerable; Special Protection; Future Generation

Introduction

More than three years ago when Dr. He Jiankui announced he had edited the genome of seven human embryos and one of them transferred into the mother's uterus and she successfully delivered a twins whose pseudonyms are Lulu and Nana in an exclusive interview with the journalist of the Associated Press just in the eve of the 3rd International Summer Meeting on Human Genome Editing in Hong Kong. [1]. The scientists and other related professionals all over the world including mainland China were really and unprecedentedly shocked, and immediately almost all of them condemned his editing of the genome of human embryos as a reckless action which is deemed as harmful to the health of these genome-edited babies. Professor Hank Greely, Center for Biomedicine and Ethics, Stanford University predicted that the near-term consequence of this kind of research could be "sick babies, disabled babies, dead babies" [2]. In contrast with his expectation of being a future Nobel Prize Laureate [3]. He was detained in November 2018 and convicted by a Chinese court in December 2019. According to the court's decision He was accused to have "deliberately violated" medical regulations and had "rashly applied gene editing technology to human assisted reproductive medicine", and sentenced for three years in prison and fined CNY 300 million (=USD 430,000) [3,4] and He also got the nickname "Rogue Scientist" [5]. Now He was released from the prison and has some contact with his native and foreign colleagues [3]. We guess he would be offered a job in some research institute. We claim that we have to turn our attention and concern to the wellbeing of the three genome-edited female babies-Lulu, Nana (born in 2018) and Amy (born in 2019) [6]. We have to point out that in this paper we only deal with the ethics of nuclear genome editing in the germline (egg, sperm, zygote, embryo), but not mitochondrial genome editing.

CRISPR entered in the vision of a wide number of scientists when gene therapy was near to a dead end [7]. Extremely interesting is that a young Spanish scientist Francisco Mojiea and his colleagues discovered that there are structurally similar short regularly spaced repeats in the genome of some species of bacteria which later formally named as clustered regularly interspaced palindromic repeats, CRISPER and called the genes near CRISPR as Cas (CRISPR-associated), and developed a hypothesis that CRISPR is possibly an adaptive immune system of bacteria against the attack from

virus and plasmid. In 2008 Sontheimer & Marrafini raised the possibility to use CRISPR to intervene or cut DNA, and first used the term "gene editing" [8]. In 2012 Doudna and Charpentier pointed out that bacteria and archaea protect themselves from foreign viruses or plasmids through an adaptive mRNA-mediated immune system called CRISPR/Cas, and that the gRNA sequence can be altered in vitro to direct Cas9 to a precise DNA sequence, thereby editing DNA [9,10].

Gene editing is an exemplar of how basic research on microbes (here is how they build and use their immune mechanisms) can be applied to medicine. Biology-based medicine offers medical scientists safer and more effective tolls of diagnosis, treatment and prevention than those only on the basis of doctors' experience. The CRISPR-Cas9 is a new technology that allows scientists to edit genomes by eliminating, replacing or adding parts of DNA sequences. It is also the most effective, inexpensive and easy method yet, allowing precise genetic manipulation to take place in virtually all living cells, even in living bodies. However, we must understand how the CRISPR-Cas9 works before we can discover its specific ethical implications. The CRISPR-Cas9 uses pair of molecular scissors to cut two strands of DNA in precise places, so the pieces of DNA can be deleted, added or replaced. Cas9 is one of these molecular scissors, attached to a piece of RNA that guides them to their desired site. So there is a question of whether the mRNA can guide it to the exact site. When DNA is cut, the cell begins to repair itself, but this natural repair method is prone to error, leading to the addition of unnecessary or deletion of normal pieces of DNA. This is where errors can occur when DNA repairs its own "wounds". So the advantage of CRISPR-Cas9 gene editing is that it is fast, easy, and cheap; The disadvantages are: low targeting efficiency: high miss rate; repair errors occurred after editing; incomplete gene editing (mosaicism); and cell may even refuse to be edited due to immunity. The coexistence of the advantages and disadvantages of current gene editing technology entails that it may bring about both risks and benefits to the patients and their offspring if we use it to modify human genome. This raise a crucial ethical issue to scientists who proceed to do human genome editing is that: Is it ethically justifiable and acceptable to use the current immature gene editing technology to modify human genome on the basis of assess the risk-benefits ratio which may be brought about by gene editing?

Gene editing technology can be applied in medicine to treat genetic diseases and gene-caused susceptibility diseases (such as individual's own single-gene genetic diseases), diseases caused by individual's own genes (cancers, genic gene, or HIV in their bodies); to prevent genetic diseases or other gene-related diseases in the family for individual's children and decedents through genome editing of germline (egg, sperm, zygote, embryo) from genetic diseases; to use for enhancement, where a person gains traits and abilities (such as night vision like cats) that exceed those of a human being (member of Homo Sapiens); and finally, to use for xenotransplantation, for example by knocking out genes that cause immune responses in pigs and some retroviruses, so that transplanting pig organs into humans does not cause immune responses and cross-species infection. Each of these applications raises special ethical questions. This paper only deal with the ethics of germline cell genome editing which is also called heritable genome editing.

Germline Genome Editing Is Ethically Unjustifiable Today Due to the Unfavorable Risk-Benefit Ratio to CRISPR Babies

Ethical problems caused by germline genome editing involves the issues of risk-benefit assessment to the patients who are the owner of germline cell (eggs and sperm, zygote, embryo) and the future parents of the children, and how to ensure them to exercise the right to informed consent, the issues of the health of the future children and their offspring, and the issues involving the other people in the society, the society as a whole and humanity. This paper focuses on two ethical issues in germline genome editing: is germline genome editing ethically unjustifiable with current immature gene editing technology and how to properly treat persons whose genome has been CRISPR-edited. We will discuss the first issue in this section, and discuss the second issue in next section.

For the application of biotechnology in the diagnosis, treatment and prevention of disease, one of the basic ethical requirements is to make a risk-benefit ratio assessment based on preclinical research which is mainly conducted with nonhuman animals, and a few of experimental clinical use which is called "innovative therapy", only the risk-benefit ratio is assessed as favorable, or beneficial to the patient, it is ethically justifiable for the technology to be clinically applied to human subjects in clinical trials. The risk mentioned here refers to the potential harm that the technology may cause to the patient's body and mind, including physical, mental and social harm; The benefits refer to the health benefits that patients may obtain from the application of this technology, including the cure of diseases, relief of symptoms, relief of pain, improvement of quality of life, and extension of life expectancy. This "health benefit" cannot be understood as a monetary benefit in any sense, so the economic term "cost-benefit" is inappropriate. The appropriate term should be cost-effectiveness. The "effectiveness" here means health benefits instead of monetary benefits. In addition to assessing the benefits and risks, there is also a risk-risk trade-off, that is the risk of intervening with a new biotechnology versus

the risk of not intervening with the technology, and we could judge which option between them is riskier. In this context we should act according to the principle of "choosing the lesser of two evils". If gene editing is performed on germline cell genome, the results of risk-benefit and risk-risk assessment may not be good for the child of the research subjects (the owners of the germline cell), that is the child whose genome is edited by CRISPR. According to experiences of preclinical research and Dr. He's study, a premature gene editing may cause the following risks [11-13].

First, off-target effects. Gene editing requires mRNA to guide CRISPR-Cas9 to the site of the defective gene for relegation, deletion or insertion, it must be required to reach the target of editing DNA. However, due to the immaturity of current gene editing technology, off-target effect often occurs. Off-target editing is performed far from the target, cutting or altering DNA (normal genes) to produce abnormal mutations. Especially if there are similar DNA sequences in the genome. Such off-target excision can cause health problems for CRISPR persons, such as cutting out tumor-fighting genes. Improved gene-editing technology may not bring the number of off-target to zero. A few DNA changes also occur naturally when cells divide. This mistake is acceptable if it does not cause serious illness to CRISPR persons. However, current gene editing technology has not reach the level at which the reduced off-target effects are acceptable [11].

Second, scientists found that even when their editing is on-target, there are unwanted, harmful, unexpected and previously unappreciated changes in genes near the target. This is a bigger problem than off-target effects. After CRISPR-Cas9 excises a DNA sequence, the cell's repair process is unpredictable, currently difficult to control, and can sometimes go wrong. According to animal studies, cells will find a random piece of DNA there to repair, or delete a chunk of DNA, a chunk of a chromosome, or even an entire chromosome in CRISPR animal babies. It turns out, for example, that when sperm genomes are edited, there are large structural mutations in the genomes of CRISPR young animals [14]. Professor Doudna, the laureate of Nobel prize commented: "At this point, we don't really understand how embryos deal with DNA repair," "A lot of work needs to be done in other kinds of embryos, just to understand the fundamentals" [11]. The current gene editing technology has not been mature to a level at which the reducing of wrong on-target could be acceptable in CRISPR babies.

Thirdly, scientists found that after gene editing, it is possible to have genetic differences not only between CRISPR individuals in a population, but also within the same CRISPR individual in animal experiment. Genome sequencing has led to the discovery that mosaics are more common than previously thought in CRISPR animal babies. An embryo that has undergone gene editing to correct the gene that causes Huntington's disease can contain cells with either a normal gene corrected or an abnormal gene that has not been corrected. This condition is known as mosaicism. Mosaicism causes two kinds of problems: if a developing embryo contains few mutated cells, it may not be necessary to remove it for biopsy; If CRISPR editing doesn't work, it leaves a lot of uncorrected cells and genetic disease. The current gene editing technology is not capable to prevent mosaicism [11].

A mature gene editing technology should be developed in the stage of preclinical research and then would be applied in human germlne cell if the scientist is responsible. Dr. He is called "Rogue Scientist" because he took a reckless action to use a premature gene editing to alter human embryo's genome before the three problems above are satisfactorily solved.

Many scientist in the world pointed out the mistakes Dr. He committed in his embryo genome editing. First, his choice of CRISPR for HIV prevention is not a medical indication, because HIV transmission is limited, we currently have a set of effective prevention methods (such as "treatment is prevention"); and knocking out CCR5 is not necessarily effective to prevent HIV, because other genes also can help HIV enter the nucleus such as the gene producing the protein CXCR4. There is no evidence to prove that the twins really are resistant to HIV virus [15].

Second, Dr. He has found that Lulu's number 1 chromosome is off target at one point. A mutation in Nana's gene was found in her placenta, which had not been detected before the implantation but was later discovered. It was also found that there is mosaicism in Lulu and Nana, that is, there are both cells with genome edited and unedited cells in their bodies. The effects of the mosaicism on the twins' health may require the examination of samples taken from the twins' organs, extensive laboratory tests and lifelong surveillance [15-17].

Third, it also matters what happened to the rest of the genome after it was edited. He did not examined the whole sequences of Lulu and Nana's genome to see if there is any abnormality after it was edited by him [15-17].

These mistakes clearly show that current gene editing technology is premature to be applied in humans, whether it is in clinical trial or in clinical practice. Due to the premature of gene editing technology, if germline cell genome is to be edited, the assessment of risk-benefit ratio would be not favorable or very unfavorable, that is, the risks will greatly exceed the benefit. And after editing, the risks would

greatly outweigh the risks of not editing at all. So there are three options for couples where one partner has a genetic disease and they want to avoid having a child with a genetic disease: having their germline cell genome edited; preimplantation genetic diagnosis performed during their zygote development to blastocyst stage; and not having children, among which the germline genome editing is perhaps the worst option. So, for whatever reason, and with or without state approval, if germline genomes are edited, the harms to the resulting children may far outweigh the benefits. In such cases, those involved, including researchers and medical personnel engaged in gene editing and their units, parents, and relevant government departments, have a corresponding moral obligations to the well-being (including health and quality of life) of these children as the victims of the application of premature gene editing technology. The application is the same with providing an unproven therapy to the patients, and it can be justified to take it as a medical malpractice for which the victims (these CRISPR-edited babies) are entitled to be compensated from accountable actors (relevant scientist, institution and the government).

Furthermore, lack of knowledge and uncertainty about the possible consequences of germline cell genome editing make it difficult to implement informed consent. When planning to have a child without a genetic disease and undergoing germline genome editing, a couple with one having genetic disease may ask a medical/scientific specialist engaged in gene editing many questions about the health of the future child and its offspring. The medical/scientific specialist may not be able to answer these questions because of the unknown and uncertainty. This made it difficult for the couple to make the decision to offer consent to germline genome editing because of the lack of information. Dr. He obtained the consent from the parents one of which is HIV positive after giving the couple CNY 280,000 yuan. This huge number of money is an undue inducement which violated the ethical guideline of informed consent and rendered the parents' consent invalid.

CRISPR-Edited Persons as Vulnerable Deserving Special Protection

The implications of discussing the proper treatment of CRIPRR-edited persons include to formulate a right policy for them which would be an essential prerequisite for successful heritable genome editing; its universal significance is to help countries to establish the necessary ethical basis for the formulation of proper policy for CRISPR-edited people; its special significance in China is to help solve the specific problems we face: how to deal with the CRISPR-edited three babies: Lulu, Nana and Amy. A right policy for CRISPR persons is based on a judgment which treat CRISPR persons as vulnerable. It is a fact that CRISPR-edited persons form a new group in human beings. This group differs from the rest of the world's 7.5 billion people in that their genomes have been CRISPR-edited. Others have genomes that are relatively natural in the sense that their genomes have not been edited in any way. So is there any moral difference between this new group and the rest of human beings?

The characteristics of this new group were: possible victims of genetic mayhem which is caused by a scientist with use of a premature gene editing technology and without medical indication, the intervention may be considered as a medical malpractice; the damage to their genomes may be passed on to future generations; they are unable to defend their rights and interests because they lack the information, resources and means necessary to maintain their physical and mental health. Therefore, they formed a vulnerable group. The CRISPR-edited babies are vulnerable in double sense: they are children who are vulnerable; and they are victims of the application of a premature technology without medical indication. The new group may be enlarged by the use of any premature gene editing technology.

Protecting the vulnerable is a feature of the Confucian ideal society labelled as "Great Harmony" (Da Tong). Confucius said that "in a society called Great Harmony all old widowers, old widows, orphans, childless elderly and disabled are well care for". (Book of Rites) In Analects of Confucius he told his disciples that "my aspiration is that the elderly be cared, friends be trusted and children be loved." [18] However, Confucians did not invent a concept "vulnerability" abstracted from their rich lived experiences on the situations of vulnerable population to guide their actions to protect this population. Edmund Pellegrino and David Thomasma systematically elucidated the concept of vulnerability in their book Helping and Healing [19]. They argue that in human relations, if there are inequalities of power, knowledge, or material means, the obligation is upon the stronger to respect and protect the vulnerability of the other and not exploit the less advantaged party. This is a principle of general ethics, applicable to all sorts of human relationships.

In health care context, the vulnerability has a special urgency, and starts with somebody being ill. The meaning of being ill is we feel unable to do what we wish to do. The symptoms lead us to seek help from physician, and then become patients. In becoming patients we enter a new existential state of dependency and vulnerability. In this state of vulnerability called illness, the body becomes the center of our concern because it is an impediment to, rather than a willing instrument for, the thing we want to do. At this moment the self dissolves into an ego and the body. So a central phenomenon of illness is the vulnerability of the sick person and the consequent inequality or asymmetry

of knowledge, power and material means in the medical relationship. This inescapable vulnerability imposes de facto moral obligations on the physician who has the obligation to protect the vulnerable patients against exploitation and provide caring to them.

In CIOMS/WHO's International Ethical Guidelines for Biomedical Research Involving Human Subjects the attempt was made to extend the concept of vulnerability to human research context [20].

In this document the title of Guideline 13 is "Research involving vulnerable persons/people" and it requires: "Special justification is required for inviting vulnerable individuals to serve as research subjects and, if they are selected, the means of protecting their rights and welfare must be strictly applied".

Who are vulnerable persons/people? In the Commentary on Guideline 13 vulnerable persons/people are defined as: "Vulnerable persons/people are those who are relatively (or absolutely) incapable of protecting their own interests. More formally, they may have insufficient power, intelligence, education, resources, strength, or other attributes required to protect their own interests" [20].

CRISPR-edited babies could be considered as no less vulnerable than research subjects in clinical research. In the clinical trials of heritable genome editing the parents of CRISPR-edited babies are research subjects, CRISPR-edited babies were at the early stage of developing embryos. Differently from ordinary clinical research the intervention does not involve the parents who are research subjects, but involve the embryos three of which were later born successfully as babies. The impacts of the intervention would be upon these babies, not upon their parents as research subjects. In this case it is justified to say that the CRISPR-edited babies should be considered more vulnerable than their parents as research subjects. When the occurrence of illness caused by genetic mayhem which has been made by the genome editing intervention, the knowledge, power and material means that they possess are much less than their parents, so the inequality and asymmetry between them and scientists/physicians are much wider than between their parents and physicians. CRISPR-edited babies are vulnerable in double sense that they are children who are the famous group of vulnerable population.

Vulnerability entails special safeguards and protections. The central problem presented by research plans involving vulnerable persons/people as research subjects is that such plans may entail an inequitable distribution of the burdens and benefits of research participation. So, special justification and safeguards are required to protect their rights, interests and welfare [21].

CRISPR-edited babies as a new vulnerable group are entitled to receive special protection. Special protection requires professionals to provide care and services which are in special need of such vulnerable group and may be much more than those in need of general patients or research subjects. For instance, in the research context, the special protection includes: Research with vulnerable group should provide benefits to the health and welfare of this group itself, not only to the health and welfare of other group; if the research would provide the benefits to all groups including vulnerable group, the research with vulnerable group should be conducted after the results prove the intervention to be safe and effective; and for the research with children, it requires to obtain the consent from their parents and also the assent from the children who have developed some degree of understanding, and the risks may not be higher than minimum [21].

The reasons against providing special protection to CRISPR-edited babies raised by our Chinese colleagues at an online meeting on the topic about how to treat CRISPR babies include: they worry that these babies would not able to live a life that a normal child lives, and that their privacy would not able to be respected etc. These worries should be included in the range of special protection. That is to say, special protection should include to provide the protection to ensure these babies being able to live a life that a normal child lives, and their individual information should not be illegitimately disclosed. All these requirements are not difficult to be provided in China because China is not a society where the media reporters and photographers could easily intrude in private life. For example, no non-insiders could know Dr. He's current situation even he was released from the prison as well as know the situation of these CRISPR-edited babies.

The special protection which we consider the professionals and the government should provide include: Regular and irregular examinations of their whole genome; their right to getting access to the physicians who are qualified at genomic knowledge and expertise when the medical practitioner is quite certain that their illness may be related with their genome; their right to know or don't know the fact of their genome being CRISPR-edited when they reach to adulthood; their right to reproduction as a normal person; their fiances' right to know or don't know the fact that fiancées have been CRISPR-edited when they prepare to marry; their right to receiving the advice and services from medical professionals having genomic knowledge and expertise when they make reproductive decision and consider the option of PDG; their right to psychological

and social care and help when they are encountered with additional psychological and social risks, such as their being stigmatized and discriminated, or possible fame and money temptation, and whenever they need to seek counseling and advice from psychologists or genetic counselors, etc. Apart from all those above we propose to set up a center to treat and study the diseases which may be related with heritable genome editing. Because if their illness be treated in general hospital and they are treated as ordinary patient, the physicians in a general hospital may not have competence to treat their illness which may be related with genome editing, and the information of their medical history in a general hospital tends to be easily disclosed. With appropriate measures, there is no reason to worry that the special protection as we proposed above would impede them to live a life that a normal child lives.

We in Present Generation Should Assume the Moral obligation to Future Generation

Bioscientists and medical professionals may know the special ethical concern caused by heritable genome editing that our action in heritable genome editing may have impact upon the health and wellbeing of future generation, but they may not know whether we in present generation have moral obligation to future generation.

The persons who live in future generation are not the decedents who are our children, grand-children or even grand-grand-children with a specific name and surname, but are those who are not identifiable and have not been born and exist, such as the persons who are the posterity of the three CRISPR-edited babies, but they would be born many years after the three die, so they have no opportunity to meet their posterity and do not their names, if the family tree of the three babies continues. So the persons in future generation may be born decades or even hundreds years after our death. The difference of germline genome editing from somatic genome editing and all other therapies lies on that the impact of this intervention would be passed along to next and future generation forever, unless they die without any decedent. Do we have moral obligation to these persons in future generation? If we don't, then there is no need for us to care about the impact of heritable genome editing upon future generation. However, the advances of science and technology and their wide applications in various social fields indicate that the actions that we take today would probably have impact upon the health, quality of life and wellbeing of those unidentifiable persons who would live in future generation and we have no opportunity to know them. However, the impact of our action upon them is real and undeniable. Global warming, epigenetics and heritable genome editing are several examples of how our action may impact upon the life of future generation.

Bioscientists and medical professionals may seriously take the justice between investigator and research subject, or physician and patient into account, because justice is one of the basic fundamental bioethical principles. However, there are two reasons to make people to tend to ignore or even deny the justice between human relations in different generations, despite of their accepting the justice between human relations in same generation. The first reason is that there is no direct reciprocity (such as mutual cooperation, exchange etc.) existing in non-same generation. The second reason is that in view of the asymmetry of power relationship which exists between the persons who live in present and those who live in the future, the persons in present generation (like us) exercised the power over future generation when we produced global warming, and then would make the persons in future generation to live a life which quality would be much lower than the life we live now, however, those in future generation won't be able to exercise power over us. In this sense the power relationship between present and future generations is asymmetric. It is same with the case in which the persons in present generation are not able to exercise power to past generation.

However, it is real that the action of persons live now may impact upon the existence (do the future exist?), the number (how many persons would exist?) and identity (who would exist?) of future persons. In short, the existence, number and specific identity of future persons depend on the decision made, and action taken by present persons. First, the decision which the persons in present generation made may end the life of some individuals, such as in the case that a couple makes decision to not having child or to undergo abortion, and a government made decision to implement restrictive population policy (like "one couple one child" policy in China) in order to control or reduce the size of population. Second, many of our decisions have an indirect effect on how many people would be born and who they would be, because our decisions may affect who meets whom and who decides to have children with whom. Third, the decisions we make today may affect the identity of the persons in the future. A person's identity is determined, at least in part, by the DNA that the person has. So our action may affect the genetic identity of the future person, because our action may affect which particular pair of egg and sperm the future person will develop from. In fact, any action that affects a person's reproductive choice will have a direct and indirect impact upon the identity of the child born from the choice [22].

The difference between the relationships of persons in the same generation to each other and our relationships to the previous and later generations raises a number of important normative issues. Since persons in the distant future and dead people have no potential to exercise power

over persons living now. Thus, for some people, immutable asymmetries of power between non-contemporaries preclude future non-contemporaries and deceased persons from making claims against present living persons. If the event that may occur to future people depend on the decision and action of those currently living, such as the existence, identity, or number of future people depending on the decision and action of those now living, to what extent could the former be said to be harmed by the latter? Furthermore, could the present persons be guided by, or take into account the interests of future persons in making these decision? Our limited knowledge of the future also means that how should we assess the different risks and possible or uncertain benefit imposed on future persons? Given that we know neither their personal identities nor their particular preferences, how can we fulfil our obligation to future people? [23].

To address these normative issues, we must analyze the logical validity and ethical acceptivity of the arguments against and for our obligation to future generation. In our opinion, first, a non-existence argument cannot be validly established. The argument goes that we have no reason to care about the persons in future generation. They mean nothing to us. They don't exist yet, and by the time they do, we'll be dead. Parents may care about their children and grand-children, or even grand-grand-children, but why care about anyone else? The simplest reason is that since the persons of future generation do not yet exist, we have no obligation to them. However, when we admonish teenage daughters not to conceive and have children at an early age when they are immature and unable to support themselves, we are thinking both of the daughter and of the welfare of the future child (who does not yet exist, but to whom we have an obligation).

Second, the no-claim argument is also untenable. It is argued that future persons do not yet have rights, so they cannot make any moral claims to us. However, we can reasonably argue that future persons will have rights in the future. If they exist, and if the concept of human right becomes a strong moral tradition, they will own it. The concept of human right is essentially an intangible cultural heritage and the future generation will recognize the concept of human right as their own moral heritage. If we leave glass in the bush now, and a child plays there hundreds of years from now and gets cut by glass, the parents of that child can't claim on us, but we do harm to that child. Don't we have an obligation to avoid that harm? [22].

Third, the reciprocity is not a condition for our obligation. It has been argued that, unlike fetuses, the persons in the distant future are unlikely to engage in moral communication with us. For example, the child could not sue us for damages, nor could she revenge on us in any way. But why must we assume that membership of the moral community extends only to those with whom we interact morally? Children are often assumed to have rights, but not because they can be compensated when their rights are not fulfilled, or because they have later obligation to care for elderly parents. Therefore, if we recognize unconditional and unilateral respect for the right of children, it is incomprehensible that the rights of future persons could be denied as the absence of such reciprocity. Suppose state A launches a missile that kills innocent residents of state B, whose right to life has been violated. Now suppose country A launches a missile, only this time it orbits space until two centuries later it kills innocent residents of state B. This is certainly also a violation of the right to life of these future victims. It is morally irrelevant that a missile hits its target directly after launch or two centuries after launch [22,24-26].

In view of our moral obligation to future generation, deciding to initiate human germline cell genome editing is not a scientific issue that can only be decided by scientists, scientific institutions and scientific communities alone, but a national issue concerning our society and the country that needs to be decided by the central government and the legislature [27].

Author Contributions

Author Lei and Author Qiu designed the research study together. Author Lei performed the research and wrote the manuscript Author Qiu provided advice and improved the manuscript in some paragraphs. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest

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