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Genetic technologies and ethics

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Abstract

In the past decade, the human genome has been completely sequenced and the knowledge from it has begun to influence the fields of biological and social sciences in fundamental ways. Identification of about 25000 genes in the human genome is expected to create great benefits in diagnosis and treatment of diseases in the coming years. However, Genetic technologies have also created many interesting and difficult ethical issues which can affect the human societies now and in the future. Application of genetic technologies in the areas of stem cells, cloning, gene therapy, genetic manipulation, gene selection, sex selection and preimplantation diagnosis has created a great potential for the human race to influence and change human life on earth as we know it today. Therefore, it is important for leaders of societies in the modern world to pay attention to the advances in genetic technologies and prepare themselves and those institutions under their command to face the challenges which these new technologies induce in the areas of ethics, law and social policies.

Key words: *Human genome, Ethics.*

Introduction

As the new age of biotechnology begins to have its impacts on modern societies in various ways, the application of such technologies in certain areas of human activities are being questioned from the ethical stand point. Although genetic technologies have a great potential to change the medical practice as we know it, it also has a potential to be misused and lead to further health disparities, discrimination and inequality in the human societies around the world. The development and use of technologies such as robotics, nano-technology, genetic engineering, neurotechnology and synthetic biology in combination is expected to become a lethal force in the hands of governments and non-governmental agents in the future if not regulated by civil and legal institutions around the world. Therefore, an effective oversight and control at both national and international levels are needed. Although some countries have adopted comprehensive national policies regarding the use of genetic technologies, most have not adopted any policies and are still debating the issues. In this brief article, I have provided a summary of the main categories of concern regarding the application of genetic technologies in medicine around the world, the generalized view of what the world believes to be ethical regarding use of the new genetic technologies in medicine and a summary of what the most developed countries in biotechnology have decided on these issues.

There are many new genetic technologies being introduced in the world on a monthly basis however; a few have been recognized to have a particular consequence for human societies across

the world. These new genetic technologies are believed to have a potential to alter human nature and society at the most fundamental levels (1). Therefore, special attention has to be paid to their use in all human societies.

Main categories for application of genetic technologies

There are three main categories of concern regarding the application of genetic technologies: 1) Human cloning 2) Genetic trait selection 3) Genetic modification. Human cloning refers to the creation of either human embryos or human children that are genetically identical to their living or dead parents. Genetic trait selection refers to selection of sperm, eggs or embryos that possess genes which are associated with certain traits. Genetic modification refers to changes and manipulation of genes in living human cells (2).

Human Cloning: The two different applications of cloning technologies are 1) research cloning 2) reproductive cloning. In research cloning, clonal human embryo is used for experimental purposes. Research cloning is also known as somatic cell nuclear transfer (SCNT). In SCNT process a nucleus from a somatic cell (e.g. a skin or muscle cell) is transferred into a female egg from which the genetic material has been removed. At the end of this process a clonal embryo is produced (2). Reproductive cloning refers to creation of a clonal human embryo, but instead of being used for experimental purposes, it would be implanted in a woman's womb and brought to term as a born child. Embryonic stem cell research in some forms involve research cloning, therefore it must be considered in the cloning debate since it does not involve modification or trait selection of genes(3).

Genetic trait selection: In this process the presence of certain genes of interest are determined in eggs, sperm and early embryos. Then, the desired eggs, sperm or early embryos carrying the genes of interest are used to create a child. In this process however, the genetic selection can be used for medically-related purposes or for non-medical purposes. For example, in medically-related genetic selection (a procedure known as preimplantation genetic diagnosis (PGD), a set of single-cell zygotes [created by IVF (In vitro fertilization] are tested for genes causing cystic fibrosis or Tay-Sachs disease and only zygotes free of those genes are allowed to initiate a pregnancy. Also in a disease such as Duchenne muscular dystrophy that is sex-linked, PGD can be used to ensure that the child born will be of the sex that does not have or carry the disease (4).

Human genetic modification: Genetic modification in humans can potentially take place at therapeutic and enhancement levels. At the therapeutic level, the illness or deficiency in a person is cured. At the enhancement level, the health condition of a person is seeked to become better than average. Genetic modification can be done either at somatic (changes of genes in cells of a person's body other than eggs or sperm) or germline (changes of genes in egg or sperm cells) levels. Germline modifications can be passed on to all succeeding generations. Therefore, in the area of human genetic modification, four possibilities exist: Somatic therapy, somatic enhancement, germline therapy and germline enhancement.

Definitions

Somatic therapy: In the past decade a number of clinical trials have been underway to cure diseases by somatic therapy (or gene therapy) such as cystic fibrosis and combined immunodeficiency. In these examples, good genes are transferred to body cells to improve cell functions (5).

Germline therapy: In this kind of therapy it is potentially possible to insert healthy genes into an early-stage embryo that is found to have diseased genes such as cystic fibrosis. Although such interventions have not been attempted in humans, the techniques are under development (5).

Somatic enhancement: In this kind of process for example, a new gene is inserted into muscle or lung tissues of athletes to increase their strength or respiratory capacity. Such enhancements have not been attempted in humans yet (5).

Germline enhancement: In this kind of process, for example, a genetic modification is attempted in muscle or lung-cell genes of an early-stage embryo to improve muscular strength or respiratory capacity in the child that results from that embryo. It has been suggested that through this process individuals can be created who have extra cognitive or behavioral traits that would constitute a new version of human species that could not breed with normal humans. Therefore, the practice of germline enhancement is viewed as a potentially dangerous approach in treatment of human disease because it has the potential to alter the human species (5).

General consensus in the world

The issues of cloning, gene therapy, and embryonic stem cell research have been at the headlines of many newspapers and magazines for over a decade in many countries throughout the world. Although some countries have passed laws on these issues, many countries have not adopted any position and do not have any laws regarding the application of genetic technologies.The following generalizations can be made regarding the ethical use of new genetic technologies in the categories discussed (6):

1. Somatic therapy is widely considered to be ethical and acceptable in the world because it creates hope to treat diseases such as leukemia.
2. Somatic enhancement is widely considered to be unethical since it could introduce new forms of inequality.
3. Germline therapy is supported by most people because it helps couples at risk of passing on a serious genetic disease, to decide on having a child free of disease by means of medically-related trait selection.
4. Germline enhancement is widely considered unacceptable throughout the world because it serves no medical purpose. It also could potentially lead to inequality among one generation over the next without their consent. Furthermore, changing the nature of human beings over the long term may have consequences that can not be predictable at this time.
5. Human genetic trait selection is generally supported because it allows a couple at risk of passing on a serious genetically-based illness to their child a chance to avoid it. However, genetic trait selection is generally opposed for non-medical or social purposes such as selection of a desired sex.
6. Human reproductive cloning is universally rejected.
7. Cloning for research purposes is supported in some countries and others strongly oppose it.
8. Embryonic stem cell research is cautiously supported because it is argued that the unused embryos resulted during the IVF procedure should be used for research purposes to gain knowledge about stem cells.

Policies of Countries

In many countries around the world, the ethical use of new genetic technologies has been discussed at the highest levels of governmental and non-governmental bodies. Based on the United Nations report (7), out of 192 countries in the world, some have adopted laws allowing or prohibiting the use of new genetic technologies in certain medical practices. The following table (table 1) is a combination of information obtained from the reports by the Center for Genetics and Society (6):

The thirty member countries of the Organization for Economic Cooperation and Development (OECD) that include Turkey, Mexico, Canada, Australia, and the United States together account for nearly 20% of world population and 84% of world GDP and have the most fully developed human biotechnology research sectors (8). The status of the policies of OECD countries regarding the ethical use of new genetic technologies in humans is given below (table 2). Table 2 is obtained from the reports by the Center for Genetics and Society (6).

Council of Europe:

The 47-member council of Europe maintains a bioethics division and has explicitly prohibited inheritable genetic modification, somatic genetic modification for enhancement purposes, social sex selection, and creation of human embryos solely for research purposes. Council of Europe in 1998 prohibited cloning human beings (9).

European Union:

European Union is a 27-member entity and has approved laws regarding the rights to the integrity of the person, and has prohibited human reproductive cloning, eugenic practices, in particular those aiming at selection of the persons and making the human body and its parts as a source of financial gain (10).

African Union:

The African Union has passed laws regarding the inviolability of the human body and the genetic heritage of the human species. It has also called for supervision of research facilities to obviate selective eugenic by-products, particularly those relating to sex considerations (11).

Group of Eight (G-8):

The G-8 countries (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States) have called for a worldwide ban on human reproductive cloning and have called for close international cooperation to prohibit the use of somatic cell nuclear transfer to create a child (12).

Conclusion

The evidence provided in this article strongly suggests that many governments and organizations throughout the world have agreed to prohibit human reproductive cloning, inheritable genetic modification and social trait selection. However, the opinion is divided regarding the research cloning and embryonic stem cell research using IVF embryos and medically-related genetic selection. There also appears to be a concern about the somatic genetic enhancement and commercialization and commodification of human reproductive practices. In many countries, it is now against the law to pay for women's eggs for research or assisted reproduction and commercial surrogacy.

As the new genetic technologies allow individuals to buy genetic materials and rent individuals for reproductive reasons, it is likely that, in the near future, pregnancy itself becomes a job that could be outsourced to gestational surrogates in the poor countries. The recent reports (9) suggest that egg trafficking is on the increase from the poor countries to the rich ones. The issues raised in this article provide the evidence that the law-makers,

political, religious and social leaders in the developing countries must quickly address these issues and provide the guidelines to the organizations and institutions involved in the practices of genetic technologies for reproductive and research purposes in their respective countries.

Table 1. Policies of countries around the world

Practice	*Prohibited*	*Allowed*	*Countries*
Reproductive cloning	59	0	
Germline modification	44	0	
Social trait selection	36	0	
Research cloning	40	14	
Embryonic SCR using IVF embryos	12	44	
Medically related trait selection	6	30	
No policies			133
Authorization of cloning			0

SCR= stem cell research; IVF= In-vitro fertilization.

Table 2. The status of the policies of OECD countries

Practice	*Prohibited (%)*	*Allowed (%)*
Reproductive cloning	97	0
Germline modification	83	0
Social trait selection	77	0
Research cloning	63	27
Embryonic SCR using IVF embryos	13	73
Medically related trait selection	10	67

SCR= stem cell research; IVF= In-vitro fertilization.

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