ETHICAL ISSUES IN GENETIC TESTING

Since genetic testing techniques are available, they never stopped being improved over the years. Theses techniques bring a greatest knowledge of the human genome. Thus, geneticists are now capable of diagnosis of genetic conditions, identification of at-risk patients for cancer... Although genetic testing has been a major revolution in the practice of medicine, it goes without saying that it has the potential to lead to ethical dilemmas. One way to explain some of them is to focus on a few techniques—genome sequencing, prenatal diagnosis, preimplantation diagnosis, and paternity testing—to then discuss some of the ethical questions they address.

GENOME SEQUENCING

Definition and a brief of history

Genome sequencing is a laboratory process for determining the order of DNA nucleotides in a genome. For the mankind, it means a breakthrough in human genome recognition. On 26th of June in 2000, it was announced in world wide that the Human Genome Project finished its 10 years long work resulting successful consequences. Venter and his group were able to identify all of the genes by reading the DNA sequences.¹ The management's most important purpose was to find a therapeutic solution for genetic disorders, for example monogenic autosomal recessive disorders.

Methods

For the methods, we should emphasis that the basic procedures come from Frederich Senger (Nobel-prize in 1978). He used a DNA primer, a DNA template, a DNA polymerase, normal deoxyribonucleosidetriphosphates (dNTPs), and modified di-deoxyribonucleosidetriphosphates (ddNTPs) to demonstrate the length of the chains with radioactive signals. As a disadvantage, this protocol was too expensive and slow (500nt/researcher/year). Then, as a relevant alteration, in 2005 automata machines were appeared to help the pace of this process. It means 1500000 nt/day, however, nowadays it is 3 billion nt /30minutes.²

Ethical issues in genome sequencing

Beside the positive effects, we should also face with the disadvantages including ethical, legal and social issues (ELSI). According to the WHO, the importance of ELSI attracts attention for 4 areas. First, genetic testing and screening. During a normal genetic examination, patients become aware of their predisposition for disorders that might occur in the future. Although, these facts do not reflect the reality. Screenings should inform its patients about the present defective genes, not other susceptibility factors. Because these cases mostly depend on the circumstances that may give a chances for a disadvantageous gene manifestation causingly unrecognized diseases. It's called „incidental findings” that might be harmful for individuals and may manipulate the patients ’ to make decision in an irreversible way. These genetic implications also have a negative effect on the patients’ relatives, too. On the other hand, it raises questions between normal and
diseased. For instance, there is a person with a cancer gene. Is this individual a sick patient or not?

Second, genetic databanks. These storages contain a lot of genetic profiles and information about small groups and communities. A worry for these data archives is the potential for the discrimination of tristful genetic groups. A knowledge of genetic risks and genetic tests could lead to discrimination inner community. For example, unfortunately in many cases stigmatization could be a form of denying attitude from health insurance or employment. Third, genetic patents. This topic presents several tricky questions about ethical and legal issues. For example, if someone invents pieces of DNA, it should count as a patent or who has a right to own biological material to all humanity. Fourth, pharmacogenomics. This area is based on pharmacology. It aims to find the most sufficient drugs and doses for the patients. Even so, it is arising questions for instance, the access of these drugs serve our benefits or not? Moreover, these pharmacogenomics’ aim is making innovation for the health interest of children, women and developing countries or not? Overall, these are fundamental issues we should consider before undergoing genetic genome sequencing.

In addition, I would mention the connection between the European countries and the conditions of genome sequencing. In Hungary, these tests are valid, but for an inaccessible price. In France, it is not legal just in emergency cases. In Romania, it is not allowed and in the Netherlands, it is valid. In conclusion, gaining the right balance between the individual’s privacy and confidentiality of his or her genetic information, with the best interest of relatives, is the real ethical and social challenge.

**PRENATAL DIAGNOSIS**

**Definition**

Prenatal diagnosis, available since the 1970’, is a method providing the ability to detect abnormalities in an unborn child. It can be performed by non-invasive methods (such as ultrasonography) or by invasive methods with, for example, the realization of amniocentesis (aspiration of amniotic fluid to diagnose for example neural tube defects) or chorionic villus sampling (to detect chromosome abnormalities).

**Ethical issues to the special circumstances of pregnancy**

Even if prenatal diagnosis can be helpful for different circumstances, the ethical issues concerning prenatal diagnosis and abortion are complex and have an important emotive component. Once the choice to perform the prenatal test has been decided by the parents, we are capable of detecting numerous birth defects such as Down syndrome or other chromosome abnormalities. The discovery of a harmful genetic disorder associated with « serious » risk of major physically or mental handicap allows parents to prepare future life with their baby, or to determine if the fetus will be aborted. In numerous cases the choice is very difficult for the parents and certain couples could live with culpability during all their life after the abortion. A lot of things must be considered such as the cost of the treatment or, the impact on their daily life if they decide to continue the pregnancy.
Abortion is also be exposed at several critics from those who hold opposing views argue on religious, moral or ethical grounds. There remain many contradictory opinions regarding the decision or the rights of the abortion, which underlines the question of the value of physically or mentally disabled people in the society.

Important interrogations are still present: how define a «serious» risk here? And can we always trust the genetic testing prediction, wrongful abortion couldn’t occur?

**Ethical issues related to diagnostic testing**

It’s only in rare cases that a treatment can be given before birth. Therefore, prenatal diagnosis mainly leads to two possibilities: abortion or decision to keep the baby with his genetic abnormalities. As there is an important imbalance between technical improvements compared of treatment improvement, prenatal diagnostic testing raises a number of important ethical issues. Knowing this inadequacy and the fact that prenatal diagnosis is associated with a small, but unfortunately definite risk of harming the fetus, how can we judge if the risks of the prenatal diagnosis worth the potential benefit? Just to illustrate, amniocentesis in some cases lead to miscarriages (risk between 0,5-1%) or to infections.

**PREIMPLANTATION DIAGNOSIS**

*Definition*

Pre-implantation genetic diagnosis (PID) is an alternative technique to prenatal diagnosis. In at-risk couples, it prevents from pregnancy termination. Embryos are genetically screened and then discarder or placed in the uterus. This technique is available since early 1990’s.

The demand is legit. Indeed, in at-risk couples, this technique prevents offspring from severe disease while avoiding pregnancy termination or miscarriage. Furthermore, the process is less stressful as the PND for the couple, and notably less intrusive for the mother who doesn’t have to go through amniocentesis or chorionic villus sampling procedures.

*The thin line between medical selection and social selection*

PID addresses the same ethical issues as PND, arising from the process of selection. Undoubtedly, the selection is made on medical criteria. The aim is to determine if the embryo carries a particular and known genetic disorder. But PID gives the possibility to look for any genetic abnormality, therefore predictive factors. The deselection based upon the presence of predictive factors for cancer or any other severe disease is not a matter of facts but statistics, probabilities, chances. We also know that we have the power to determine beauty and intelligence.

The main question is: what is the difference between a medical criterion and a social criterion? In other words: do we want healthy babies or perfect babies?

For example, embryos with intersex trait can be deselected in the US. The population stigmatizes intersex people. However they can have a fulfilling, healthy and happy life.  

*Savior sibling*
A savior sibling is a child who is born in order to provide stem cells to his or her older sibling, suffering from a severe and incurable condition. Certainly, the process requires a selection process: the savior sibling has to be healthy and HLA-compatible; the same selection process that raises the ethical issues about eugenics.

Still, the first questions coming across our minds are: is it principled to use an unborn baby to medical purposes? Did the parents wanted another child?

It is possible to give some answers to these questions. Generally, we all use each other, for work, for school, in our families... This is how the society works: we all have a role, and it doesn't seem unethical. What is generally accepted as unethical is to use a person only as a mean. Therefore, if the savior sibling's stem cells are used to cure his or her older sibling, and then, the baby is part of the family, loved and cared about, it is not considered as immoral.

PATERNITY TESTING

History
- 1920s: abo ab0 blood typing. often not conclusive, power of exclusion was only 30%
- 1930s: serological testing: other genetically inherited antigens (rh, kell & Duffy) together with ab0 blood typing power of exclusion was only 40%
- 1970s: hla (mhc) testing. combined with blood typing and serological testing a power of exclusion of 90% could be reached. a problem with this method is that it requires a big blood sample.
- 1980s: rflp (restriction fragment length polymorphism): dna extracted from the blood, again required a big blood sample. the power of exclusion however was about 99.99%
- 1990s: in the 1980s pcr was developed, since 1990 this is the standard method for dna testing.

Methods
Invasive: see prenatal screening
Non-invasive: dna of the foetus can be found in the blood of the mother
In adults/children: the dna of a child or adult is used, most of the times it is acquired from the cheek

Legality
In a lot of countries paternity testing is legal, however, in most countries there are some restrictions.
Example: in the US paternity testing is legal even without the consent and/or knowledge of the mother. the tests can be ordered online but are only for personal knowledge (i.e. they give no legal ground). in Germany consent of both parents is required, the fine for testing without consent is €5000 euro.
In France genetic testing is illegal. it is regulated by the state and only permitted in specific cases.
The idea behind this is that paternity is socially determined and not biologically. However, there are french men who send DNA samples to laboratories in foreign countries. the penalty for this illegal testing can be up to one year in prison and a €15,000 fine.

Ethics
The question about the ethics of paternity testing leads us to the question of what determines paternity.
Imagine: A child is raised by a man and knows this man as his/her father. The people in the social environment also identify this man as the father of the child.
However, the child is actually not the biological child of this father. The biological father is someone the child never met but is the origin of half of his/her DNA. The question is: What is more important? The emotional bond the child has with the father who raised him or the origin of half of the genes in the body of the child.

Another question that should be discussed is: who will profit from the results? It is very well possible that the child never doubted the fact that his father is his/her biological father. Is it ethically acceptable that the father tells his child about having doubts and lets the paternity be tested just to know for his own peace of mind?

**CONCLUSION**

In conclusion, new genetic testing techniques brought some innovation and some new possibilities. As with every medical development, these new possibilities come with new ethical dilemmas. To manage them, law and ethical fields must cooperate.

**REFERENCES**

1. Pal Venetianer; MTA; 2011
2. HGN activities in ELSI of human genomics; Genomic Resource Centre, WHO
4. Davis, Georgiann (October 2013) « The Social Costs of Preempting Intersex Traits » *The American Journal of Bioethics*
5. Website of the DNA diagnostics centre (http://www.dnacenter.com)
6. Pollack, Andrew (June 2012) « Before Birth, Dad’s ID » *The New York Times*
7. Translated French civil code (July 2013)