

## The use of artificial intelligence in pre-implantation genetic diagnosis under the ethical-legal perspective\*

### *Da utilização da inteligência artificial no diagnóstico genético pré-implantacional sob a perspectiva ético-jurídica*

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#### Abstract

Assisted human reproduction, combined with the auxiliary method of pre-implantation genetic diagnosis, makes it possible to carry out the parental project, removing pathological risks related to genes and contributing to the selection of genotypic characteristics of the offspring. It so happens that the legislative inertia in the face of this topic leads to relevant discussions about the limits of the issue, especially when including artificial intelligence to optimize the results of genetic selection. In view of this, the present study analyzed, through the hypothetical-deductive method, based on research and bibliographic review, the ethical and legal aspects that permeate the use of artificial intelligence in pre-implantation genetic diagnosis. For that, we examined characteristics, techniques and deontological and legal foundations of assisted human reproduction. Likewise, the attributes of the pre-implantation genetic diagnosis were investigated, focusing on its recurrence through artificial intelligence. Although it is evident that there is a lack of legislation that specifically regulates the theme, it was found that the realization of the referred diagnosis for purposes other than therapy represents an eugenic practice, which is enhanced by the use of artificial intelligence, instrumentalizing the human body and violating numerous precepts such as the dignity of the human person.

**Keywords:** Bioethics. Artificial intelligence. Assisted Human Reproduction.

#### Resumo

*A reprodução humana assistida, aliada ao método auxiliar do diagnóstico genético pré-implantacional, viabilizam a concretização do projeto parental, afastando riscos patológicos correlatos aos genes e contribuindo na seleção de características genotípicas da prole. Ocorre que inércia legislativa perante o tema acarreta em relevantes discussões acerca dos limites da temática, sobretudo quando se inclui a inteligência artificial para otimizar os resultados da seleção genética. Diante disso, o presente trabalho analisou, por meio do método hipotético-dedutivo, fundamentado em pesquisa e revisão bibliográfica, os aspectos éticos e jurídicos que permeiam a utilização da inteligência artificial no diagnóstico genético pré-implantacional. Para tanto, examinaram-se as características, técnicas e fundamentos deontológicos e jurídicos da reprodução*

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*humana assistida. Da mesma forma, investigaram-se os atributos do diagnóstico genético pré-implantacional, com enfoque a sua recorrência por intermédio da inteligência artificial. Embora se evidencie a carência legislativa que regulamente especificamente o tema, constatou-se que a realização do referido diagnóstico com finalidades para além da terapêutica representa uma prática eugênica, a qual é potencializada pelo emprego da inteligência artificial, instrumentalizando o corpo humano e violando inúmeros preceitos jurídicos, como a dignidade da pessoa humana.*

**Palavras-chave:** Bioética; Inteligência Artificial; Reprodução Humana Assistida.

## 1 Introduction

Assisted human reproduction (RHA) is a relevant instrument for the realization of the fundamental right to family planning, as it helps or even solves certain adversities correlated with human sterility or infertility. With the increasingly late search for pregnancy by women, requiring medical fertility and/or fertility treatments aimed at older age groups; with the diversity of family configuration, especially single-parent, homoaffective and co-parental, which can seek in asexual reproduction the reach of offspring; with the possibility of selecting, through eugenic techniques, gametes and embryos that are healthier or that have specific characteristics; it is noted that, nowadays, people resort more frequently to the use of assisted human reproduction techniques (HRT).

From the perspective of assisted human reproduction is the preimplantation genetic diagnosis (PGD), which is an auxiliary method usually used by individuals or couples who present risks in reproduction. In addition to making it possible to previously identify the genotype of embryos for the purpose of selecting and removing genes unwanted from the offspring (correlated with pathologies), it also enables embryonic genetic selection according to the preference of the parent(s) - such as eye color, hair and skin; biological sex; among others -, functioning as a eugenic tool.

In recent decades, society has witnessed several advances in the field of human reproduction, with the inclusion of artificial intelligence in preimplantation diagnostic tests being one of the most significant events in the reproductive medical field. This fact arose from the possibility of this test optimizing the identification, with a large margin of accuracy, of the existence or not of embryos carrying severe anomalies, before their transfer to the woman's uterus, thus ruling out the occurrence of transmission of genetic diseases.

However, what is currently being questioned is whether preimplantation diagnosis can be used to determine and alter other human characteristics, as mentioned above, or be used for positive eugenics practices. These facts are visibly aggravated by the use of artificial intelligence, which has as its main objective the selection of healthy embryos, and can, on the other hand, lead to a search for human "perfection", violating ethics, morals and legal precepts.

Due to these factors, relevant questions and reflections are raised about the power that is transferred to a third party, in this case the parent(s), to define genes in advance, through genetic manipulation - from the use of artificial intelligence - of the processes of biological life, relativizing the value of life and instrumentalizing human bodies, justifying the need to verify the limits of the use of these techniques.

To clarify the theme proposed here, a historical retrospective will be carried out on assisted human reproduction as an auxiliary medical technique in the fight against infertility, presenting its main characteristics, emphasizing the preimplantation diagnostic exam, since it currently resides the greatest role of artificial intelligence focused on the area of biotechnology.

After overcoming this understanding, artificial intelligence will be analyzed as a branch of computer science that proposes to develop systems that simulate the human capacity in the perception of a problem, identifying its components and pointing out solutions. In this sense, artificial intelligence as a whole will be studied, in order to understand how its performance is specifically focused on the health area and how it has been used for the issuance of technical opinions.

Then, the stir will be examined, aiming to understand the possibility of using preimplantation diagnosis to determine and change the genotypic and, consequently, phenotypic characteristics of the offspring, such as the baby's choice of sex, eye color, hair color, etc. Therefore, the ability of an exam to be used for positive eugenics practices will be questioned. a context that can be visibly aggravated by the use of artificial intelligence, which has as its main point the search for perfection and is often faced with the absence of ethics.

To explore the proposed objectives, it is emphasized that the eugenic perspective of improvement can also be associated with embryonic disposal due to the finding of minimal or inexpressive pathologies, which do not make the development of extrauterine life unfeasible. In this sense, it will be verified whether or not biotechnologies question the very nature of the human being in its molecular structure, offending the human genetic heritage and human dignity.

This understanding is necessary since there is no specific legislation in the Brazilian legal system that regulates the scope of preimplantation genetic diagnosis, only Resolution No. 2,168/2017 of the Federal Council of Medicine, which has no normative power and does not allow the use of preimplantation diagnosis as it is presented, so that it is possible to objectify the embryo, being vulnerable by nature, and the direct offense to the dignity of the human person.

To enable the present study, the hypothetical-deductive method will be used, based on research and bibliographic review of books, journal articles, national and international legislation and doctrine applicable to the case, especially in the areas of Health, Legal and Computer Sciences, about assisted human reproduction and artificial intelligence, especially preimplantation genetic diagnosis.

## **2 Assisted human reproduction**

Assisted human reproduction techniques are characterized as an essential tool for achieving the consecrated right to free family planning<sup>2</sup>, breaking with the limits of infertility and enabling those who, in one way or another, encounter difficulties or biological impossibilities to do so.

From the Brazilian legal perspective, it is worth noting that - despite the relevance of the topic and its impacts on people's lives - assisted human reproduction is not regulated by national legislation, it is only managed by criteria defined by the Federal Council of Medicine, through Resolution No. 2,168/2017 (Federal Council Of Medicine, 2017), which has an eminently deontological character and is directed to doctors and clinics that perform this procedure.

Although the issue of infertility has been constantly highlighted in medical and scientific discussion over time, assisted human reproduction techniques only achieved their success in 1978, with the birth, in England, of the first test-tube baby, Luise Brown, the result of artificial reproductive techniques developed by Robert Edwards, professor emeritus at the University of Cambridge (Moraes, 2018, p.65).

In Brazil, the first birth resulting from in vitro fertilization took place in 1984, in the metropolitan region of Curitiba/PR. It is estimated that, in the last decade, about 15 to 20% of the world's population had some type of infertility, resulting from a multiple range of factors, ranging from age, biological sex, diet, exposure to pollution, medical error, etc. (Scalquette, 2010).

In this sense, assisted human reproduction techniques represent palliative processes of asexual reproduction, which have as a background the manipulation of gametes and embryos

<sup>2</sup> Family planning is a fundamental and personality right provided for in article 226, § 7 of the Federal Constitution of 1988, in article 1,565, § 2 of the Civil Code, in addition to being regulated by Law No. 9,263/1996, being understood, in the present work, as the set of actions to regulate fertility that guarantees equal rights of constitution, limitation or increase of offspring to every citizen, regardless of their marital status or sexual orientation.

in order to circumvent the natural barriers that prevent procreation in a natural way. It is said to be palliative, because the condition of infertility is not changed, but there is a facilitation of pregnancy, a mockery of the system (Cardin, 2015, p. 37-38).

For Meirelles (2008), the best qualification of assisted human reproduction is far from what many doctrinaires<sup>3</sup> call "artificial". For the author, these are mere "interferences" in reproduction, because - even when the so-called artificial techniques are employed - the process does not cease to have its natural bias, it only removes the need for the occurrence of sexual intercourse.

For the present work, both the expression "interference" and "artificial" are used to qualify the term assisted human reproduction. Therefore, this will be any type of human reproduction in which health professionals intervene to enable its good realization through techniques, methods and procedures, such as: the administration of medications, hormonal supplementation, artificial insemination, assisted fertilization, gamete and embryo transfers, cloning, among other means.

These are possibilities that allow, considering each specific case, a better adaptation and solution of the various hypotheses of infertility, with efficiency and minimization of risks and losses. It is clarified, with this, that assisted reproduction is the generic designation of fertilization techniques in the laboratory.

There are countless types of techniques that make up the whole of assisted human reproduction. For example, *in vitro fertilization* (IVF) is appointed, which consists of extracorporeal fertilization, that is, one or more eggs are selected and removed from a woman and fertilized in the laboratory, and these are later introduced into the uterus of the future pregnant woman (Corrêa, 2009, p. 76-78).

Another commonly used assisted human reproduction technique is artificial insemination, a procedure in which semen is introduced into the female body in an instrumental way, facilitating fertilization. In other words, the artificial procedure overlaps with the first phase of the natural reproductive process, in which the sexual act is a *sine qua non* condition for the deposition of male gametes in the female reproductive system (Alves; Oliveira, 2014, p. 67).

Assisted human reproduction techniques, in general, can be performed in two different ways. In the first, called homologous, the gametes of the person involved in the parental project are used. This is the case of using, for example, the spermatozoa introduced into the woman belonging to her husband or partner. In the second possibility, called heterologous, the genetic

<sup>3</sup> Maria Helena Diniz, Ana Cláudia Silva Scalquette, among others.

material partially or entirely does not belong to the idealizer(s) of family planning. It occurs, for example, when the spermatozoa, the ovum or both genetic materials of a third party is adopted, the result of an anonymous donor(s) and unrelated to those who orchestrated the realization of the parental project (Cardin; Cazellatto; Guimarães, 2018, p. 171-172). There is also biseminal reproduction (a subspecies of heterologous), in which the male fertilizing material belongs to two different people, usually the husband or partner and the donor (Ferraz, 2016, p. 45).

It is possible not to mention the possibility that, concomitantly with assisted human reproduction techniques, there may be a need to use surrogacy in certain situations, also called surrogate motherhood, especially in cases of health problems that compromise the pregnancy or the health of the pregnant woman.

Other possibilities for using surrogate motherhood are for homoaffective, single-parent and coparental families<sup>4</sup>. This is because the free implementation of family planning, including that which uses assisted human reproduction techniques, is a fundamental and personality right, not restricted by discriminatory issues either in terms of marital status or for reasons of affective-sexual orientation or gender identity of its holders.

In this regard, Krasnow (2019, p. 5) also adds that:

*Oncluye que en sintonía con el principio de pluralidad, se define con un alcance amplio estos procedimientos en relación con sus destinatarios. In this line, I can use the partners of equal or distinct sex married or cohabiting, as well as men and/or women who do not conform to the pair.*<sup>5</sup>

To this end, Resolution No. 2,168/2017, of the Federal Council of Medicine, establishes some minimum requirements that permeate surrogacy, which are essential: (i) the temporary donation of the uterus must be free of charge, and any profit or commercial purpose is prohibited; and (ii) the uterus donor must be a relative of the genetic donor up to the 4th degree or, in other cases, with authorization from the Regional Medical Councils (Conselho Federal De Medicina, 2017).

In addition to assisted reproduction techniques, there may be the use of exams aimed at verifying the viability conditions of gametes or even embryos, seeking to provide results with higher rates of live birth of the offspring. This is the so-called preimplantation genetic diagnosis

4 Regarding plural family configurations, especially coparental family conformations, read: Viegas; Pamplona Filho, 2020.

5 "It is verified that, according to the principle of plurality, these procedures are defined with a broad scope in relation to their recipients. In this line, married couples or cohabiting of the same or different sexes can use it, as well as men and/or women who do not form a couple." (Free translation).

(PGD), a procedure that, through embryonic selection, identifies chromosomal abnormalities and genetic mutations, among other possibilities, of the embryo before its intrauterine implantation (Pompeu; Verzeletti, 2015, p. 85-87).

### 3 Preimplantation genetic diagnosis

With the significant scientific and technological evolution in the area of genetics and human reproduction, genetic analysis techniques were developed that, in addition to making it possible to read the human genome, made it possible to predict the occurrence of genetic pathologies or even their predisposition in individuals with no symptoms.

The central idea of preimplantation diagnosis is linked to the "search for efficacy at all costs" (eugenic connotation), which allows embryo selection through assisted reproduction techniques, specifically *in vitro* fertilization, so that, in the face of the identification of certain genes, especially those that carry genetic anomalies, only "satisfactory" embryos are given the opportunity to live (Cardin, 2015, p. 61-64).

As Pinheiro (2005, p. 770-771) asserts that preimplantation genetic diagnosis is not a technique of medically assisted procreation per se, but rather an auxiliary method to artificial reproduction, since its sole objective is to select the embryos that will be implanted in the woman's uterus, identifying the existence of embryos carrying serious anomalies before their transfer to the woman's uterus – discarding. Thus, the occurrence of transmission of a genetic disease.

For Andorno (1994, p. 323-324), this auxiliary method can be visualized in two stages: the first concerns embryo selection, consisting of a genetic analysis so that only "normal" embryos (according to parental wishes) are implanted in the uterus; and the second, in turn, consists of genetic improvement ("better quality").

Kalline Carvalho Gonçalves Eler *et. al.* (Eler; Branches; Oliveira, 2019, p. 3) the purposes of preimplantation genetic diagnosis:

Prior genetic knowledge allows corrective actions that are exercised in two ways. It is possible to identify the genotype of the embryos (which will be implanted) and, through personalized treatments, prevent the enzymes or proteins that generate an unwanted gene from being expressed, thus avoiding certain diseases with genetic predisposition. In the same way, it is also possible to study the genotype of several embryos in advance and choose only those that present the desired characteristics, thus selecting the genes that determine the characteristics of the parents' preference, using some of the embryos and discarding the others.

Therefore, although these procedures may seem, at first, to be a mere benevolent intention, it is possible to identify the existence of a negative facet in the preimplantation diagnosis, that is: the discarding of embryos listed as unhealthy, but which have, like the others, the potential for life. It is precisely in view of this that the differentiation between selection for therapeutic purposes and eugenic practices arises.

On the subject, Prada (1995, p. 154) argues that:

In general, non-therapeutic germline modification procedures are *in themselves* contrary to human dignity and should therefore in no case be considered patentable. This would be the case of hereditary physiological modifications (changes in eye color, taller, blond, slender individuals) and, in short, positive or negative eugenics or the creation and selection of human races by man himself, which in some cases could violate the constitutional principle of the free development of personality and, even in the most advanced countries, constitute criminal offenses.

Regarding negative eugenics<sup>6</sup>, Moraes (2018 p.145) points out that 3% of American couples who underwent in vitro fertilization treatment chose embryos with genetic anomalies to be implanted, because their desire was to have children with the same characteristics as theirs, even if this choice implied some disability, affronting all the principled dictates of the dignity of the human person.

It is emphasized that the recurrence of genetic engineering techniques represents a risk that genetic modifications are made in favor of an "improvement" or "purification" of the genetic composition of the human being, which may result in a new kind of social segregation, the "genetic background".

In this sense, when debating which characteristics are or are not harmful about genetic diagnosis, Ana Cláudia Silva Scalquette (2010, p. 97) emphasizes that this choice involves an evaluative judgment, which may elect "[...] discriminatory criteria that serve the interests of a dominant class, whether for political, economic or social power".

What can be seen is that the new reality brought about by the reach of assisted reproduction and genetic manipulation techniques brings a series of bioethical and philosophical issues that need to be studied and debated.

As already explained, in Brazil, one of the main ethical and administrative instruments for regulating the use of assisted human reproduction is Resolution No. 2,168/2017, of the Federal Council of Medicine, which provides for the possibility of carrying out preimplantation genetic diagnosis, however it can only be carried out for the purposes of diagnosis, prevention

6 For a deeper understanding of the definition and characteristics of eugenics, it is recommended to read: Mai; Angerami, 2006.

or treatment of diseases, never for eugenic purposes, that is, for racist, sexist, ethnic values, among others. In case of identification of genetic pathologies in the embryo, these can be "[...] donated for research or discarded, according to the decision of the patient(s) duly documented in specific free and informed consent" (Federal Council Of Medicine, 2017).

On the other hand, it should be noted that there is no authorization for the use of this method for the purpose of selecting the sex (presence or absence of the Y chromosome) or any other biological characteristic of the future child, except when it comes to avoiding diseases in view of the genetics of the parents.

In this context, the provision of the Resolution of the Federal Council of Medicine reveals the respect, protection and promotion of the principle of human dignity, enabling the parent(s) to carry out the parental project, generating healthy children and, at the same time, protecting the embryo, considering its potential to become a human being.

In addition, the resolution brought another possibility, that of selecting the type of the embryo aiming at its genetic compatibility with a sibling, who is affected by some disease and whose effective treatment is through stem cell or organ transplantation (Conselho Federal De Medicina, 2017). It is the so-called "medicine baby". In this scenario, not only the diseased embryos are discarded, but all those that are not compatible with the genome presented by the sick sibling.

Regarding this technique, Leandro D'Ornellas (2011 *apud* Cardin, 2015, p. 71) points out that "[...] The criticisms against the procedure are numerous since it instrumentalizes the human being to the extent that the child (drug-baby) is not born for what he himself represents, but to help the sick brother". Therefore, babies are produced for a single purpose, to be used as biological material to treat someone else's disease.

On the subject, Habermas (2010, p. 29) makes some essential questions:

The application of the preimplantation technique is linked to the following normative question: Is it compatible with human dignity to be generated with a reservation and, only after a genetic test, to be considered worthy of an existence and a development? Can we freely dispose of human life for the purpose of selection? A similar question arises with regard to the aspect of the "consumption" of embryos (including from the somatic cells themselves) in order to meet the vague hope of one day being able to produce and graft transplantable tissues, without having to face the problem of overcoming the barriers of rejection of foreign cells.

This type of technique, when used for non-therapeutic purposes, puts into practice the so-called liberal eugenics, which directly affronts the Federal Constitution, especially its article 3, item IV, which prohibits any and all forms of discrimination, including genetic discrimination, even if implicitly.

One of the mechanisms that has been gaining strength in assisted human reproduction, especially in preimplantation genetic diagnosis, is the use of artificial intelligence (AI) to succeed in the screening of the embryos most apt to have their full and healthy developments, as well as in the selection of genes, which will impact the phenotype of the offspring to meet the desires of the creators of the parental project. These factors raise a series of instigating ethical and legal questions and reflections about human objectification due to manipulation and consequent genetic discrimination.

#### **4 Incorporation of artificial intelligence in assisted reproduction**

Currently, medicine has used artificial intelligence<sup>7</sup> to improve the certainty of diagnosis, prognosis, and treatment offered to patients in the most diverse areas, such as neurology, oncology, cardiology, dermatology, and gynecology.

This fact arises, as Lugo-Reyes *et. al. clarifies*. (2014, p. 111), the high rate of incorrect diagnoses in the practice of clinical medicine, which currently has an error variation between 10 and 20%, depending on the field of medical science. This is mostly due to the fact that clinical diagnosis is a complex cognitive process, which requires experience, training, pattern recognition and conditional probability calculation, among other less important components, such as the professional's fatigue, social reality, length of service, experience, etc.

In this sense, in 2009, it was found that 32% of medical errors in the United States of America (USA) resulted from a decrease in the time of interaction between the physician and patients, producing misdiagnoses, non-recognition of urgency or worsening of the patient's evolution that would require prescribing or performing pertinent actions (Lobo, 2017 p. 187).

According to Tacca and Rocha (2018, p. 59), artificial intelligence translates into systems that are programmed, trained, and planned to learn to complete tasks traditionally performed by humans, because "the focus of these computer systems is to look for patterns in data available in the environment, test them, and find, or even provide results or make decisions".

7 According to Luiz Carlos Lobo (2018, p. 1) artificial intelligence "[...] It is a branch of computer science that proposes to develop systems that simulate human capacity in the perception of a problem", identifying its components and pointing out solutions. The system acts, therefore, autonomously, without the need for direct instructions from human beings. Artificial intelligence, after being predetermined, follows a schedule of movements and actions that use algorithms and strategies that allow for better decision-making. According to Simon Haykin (2008), an artificial intelligence system must be able to store knowledge and apply it to solve problems in order to acquire new knowledge through experience.

From a medical perspective, artificial intelligence systems seek to offer a list of possible diagnoses for a health problem, with the probability of success, using data from the genesis and evolution of this problem, evaluating signs and symptoms of patients, and proposing diagnostic possibilities (Coeira, 2014).

Thus, artificial intelligence programs aimed at the medical field are based on symbolic models of nosological entities (classification of diseases) and their relationships with factors related to the patient and clinical manifestations. These are programs designed to acquire and make available the operational knowledge of a human specialist in a certain area or field of activity (Guarazi; Vendramini, 2014, p. 27-28).

To this end, artificial intelligence systems use the so-called Neural Networks, which are nothing more than the representation of the functioning of the human brain, coming from a computer system. An artificial neuron is then created, which is nothing more than a logical-mathematical structure that seeks to simulate the form, behavior and functions of a biological neuron, based on the capture of human processing and memory of information. (Guarazi; Vendramini, 2014, p. 34)

Currently, neural networks are associated with *machine learning*, which can be described as the science (or art) of programming computers so that they have the ability to learn something that is not explicit in their programming (Géron, 2017 p .07).

This association also receives a set of API's (*Application Programming Interface* ), responsible for creating a service specialty in the system, allowing the user to create cognitive systems to meet their needs (Lobo, 2017 p. 188-189).

It can be observed, therefore, that the use of all systems perfectly simulates the human mind, with all its synapses and logic, but in milliseconds and with an extraordinary range of action.

According to Lobo (2018, p. 43) states that there are already studies pointing to the combination of artificial intelligence systems with the evidence-based medicine (EBM) method – which examines the relationship between a limited number of pre-defined variables in a small sample (hundreds or thousands of people) obtained from various sources (electronic medical records, administrative data, wearable and body devices, genomes and social determinants) so that the diagnosis given and, consequently, its treatment, evaluates not only global data, but also real data, close to the patient's experience of the place and reality, thus obtaining a decision of high medical-scientific content.

Parallel to all this, there is also the robotic activity that creates physical agents that perform tasks by manipulating the physical world, for this, they are equipped with effectors,

such as: legs, wheels, joints, claws and other components that simulate the performance of human accessibility (Russel; Norvig, 2004, p. 54-66).

Most of today's robots, according to Stair (2006 p. 56), fall into three types of categories: manipulators, mobile or hybrids:

[...] Manipulators are arms or claws fixed in a certain location that assist in the industrial assembly line. Furniture, in turn, is those capable of moving by means of wheels, legs and the like, usually used in hospitals and food production. Hybrid robots are those that have both characteristics, they are therefore humanoid types, very expensive and little used in manufacturing in general.

Artificial intelligence has become widely used in the field of gynecology, especially since the creation of the genetic algorithms (GA) technique, creating genetic associations based on Charles Darwin's principle of natural selection and population data and being able to accurately measure the combination of *deoxyribonucleic acid* (DNA)<sup>8</sup> between fathers and mothers, comparing them with a basic genomic sequence of each being (Nogueira *et. al.*, 2018). In this way, it is possible to point out the probability of the genomic sequence being the same or mutating, which means, for this article, the possibility or not of a child reproducing a certain pathology of genetic origin.

For this calculation, the researchers use the so-called sequence alignment that, according to Richardson Lima (2007, p. 31), "[...] It is a process that superimposes the sequences to be analyzed in order to obtain a level of identity between them. This level expresses the similarity between the sequences compared", which is responsible for determining the probability of this embryo to reproduce genetic flaws. As a result, any embryo that has a high potential for reproduction of this unwanted genetic load is not implanted in the uterus, that is, it is discarded.

On the other hand, the result of the test does not eliminate the possibility of genetic alterations (monogenic inheritance) or congenital malformations not suspected or known at the time of the test. Thus, although the preimplantation diagnosis has a 95.3% success rate, it is not incorruptible (Dantas; Chaves, 2018, p. 132). Raposo (2007, p. 59) clarifies that, although the diagnosis does not work as an absolute guarantee of a healthy child, it is certain that, currently, it is one of the most effective ways to ward off a series of diseases in programmed pregnancy.

What is questioned, however, is not the effectiveness of the system, nor the ability of the machine to point out and quantify the probability of genetic reproduction of each embryo, but rather the scope and ethical bias of this procedure. This is because, as previously stated, even though diagnosing genetic diseases in the embryo seems legitimate, it is worth remembering

8 Deoxyribonucleic acid (DNA).

the prospect of eugenic practices, which would try not only to ward off diseases, but also to select the embryo, or even to determine certain genes that will prevail in the offspring and, consequently, structure a "perfect human being".

## **5 Ethical and legal aspects of the use of artificial intelligence in preimplantation genetic diagnosis**

Genetic manipulations make it possible to hope for an improvement in the quality of life, with less suffering, through gene therapy. However, serious ethical questions can be raised against these possibilities, since there is a very thin line between preventive and curative practice and eugenic practices, of creating hybrid beings, which can irreversibly modify the nature of the species, causing even more pain and suffering to human beings.

The theme of eugenics is quite controversial and generates many conflicts largely due to the horrors committed by Nazism in the 40s, which sought racial purity in the name of proposing the elimination of ethnic groups considered inferior, notably the Jews. Thus, genetic manipulation techniques must receive redoubled attention and consistent with the criticism made here (Cardin, 2015, p. 61).

There are two forms of eugenics, the negative, which is the one that eliminates undesirable traits, avoiding, for example, the genetic transmission of diseases, and the positive, which is the explicit conduct of selecting gametes aimed at obtaining desired traits. The classification, therefore, refers to the selective conduct of favoring or removing characteristics (Cardin, 2015, p. 62-63).

In this sense, the problem of work resides in the field of positive eugenics, the one that clearly determines the predilections and choice for genetic improvement. Santos *et al.* (2013, p. 154) for whom the general concern is especially located in what is called liberal eugenics, understood by Habermas (2010, p. 18-22) as a form of instrumentalization/objectification of the human body.

In this aspect, it is undoubted that biotechnology challenges not only nature, but the human being itself in its molecular structure, since the human genetic heritage is not subordinated to a "will of will". In this sense, Habermas (2010, p. 18) argues that the understanding according to which there is the possibility of intervening in the human genome "[...] with the permission for transformations that depend on preferences and that do not need any self-limitation", especially if we consider research with embryos and preimplantation genetic diagnosis.

It is verified, therefore, that in the name of the human dignity of the individual, it is not necessary to tolerate selective practices that are far from strictly therapeutic purposes or that border on genetic improvement (positive eugenics). Having verified the possibility of preimplantation genetic diagnosis being used for purposes other than therapeutic ones and verifying that artificial intelligence will always seek the purity of the genome, the questions that persist are: how to delimit the scope of preimplantation diagnosis? What should or should not be considered as an intervention harmful to human beings and the human genome? Would the genetically modified individual see himself in the same way as the naturally generated one? What influence does it have on your consciousness when you know that a third party chose you genetically? Could the genetically modified individual be considered superior or inferior to naturally generated individuals?

At this point, it is necessary to remember that Bioethics is based on respect for the life and dignity of the human person, in addition to other principles such as solidarity, responsibility and respect for the self-determination of the person, and the eugenic programming of hereditary heritage is unreasonable.

With this in mind, Law No. 11,105/2005, also known as the Biosafety Law, expressly prohibited, in its article 6<sup>o</sup>, the performance of genetic engineering in living organisms or *in vitro* in germ cells, zygotes or human embryos (Brasil, 2005). Such a command is justified by the fact that the genetic heritage that is transmitted to the offspring, therefore, any alteration in it harms the genetic lineage, generating an extreme vulnerability to the human being.

Regarding this vulnerability, Eler *et. al.* (2019, p. 11) is inseparable from ethics, because:

[...] Respect for the vulnerable must drive scientific advances, medical practices, and reproductive technologies, implying an imperative of collective responsibility, which translates into a duty of care. If before man's actions produced only individual consequences, today they are capable of affecting the entire social body. The capacity for self-destruction is easily demonstrated with the changes in the biological structure of humanity, resulting from genetic improvement practices, which can compromise the basis of what it is to "be" human.

However, this standardization is not able to prevent the preimplantation genetic diagnosis from being used by a totally different bias from the one to which it was envisioned, the fact is that the selection of embryos without pre-established criteria can cause the possibility of positive eugenics and, consequently, offense to the condition of human being. Once the inertia

9 "Art. 6 - It is prohibited: III - genetic engineering in human germ cells, human zygotes and human embryos." (Brasil, 2005).

of the Legislative Branch in regulating the subject in a specific way is verified, legal discussion and reflection are necessary in order to find paradigms and solutions in case of any conflicts.

In this case, it is essential to resort to the principle of the dignity of the human person, the normative and axiological epicenter of the Brazilian legal system, to try to provide special protection to the embryo. Thus, returning to the core idea that dignity, as an intrinsic quality of the human person, is inalienable and inalienable, it is seen that it cannot be an element of human predetermination.

Based on the principle of the dignity of the human person, the human being must be an end in itself, therefore insusceptible to instrumentalization (Barroso, 2013, p. 38), which, in the embryonic field, can be visualized when clinical experimentation for preimplantation diagnosis outside the therapeutic purposes.

Based on this concept, it is concluded that, in view of the existence of human dignity as a principle, the possibility of genetic reductionism remains incompatible with the legal system, and the use of genetic data for discriminatory purposes is rejected (according to Article 7 of the International Declaration on Human Genetic Data), and genetic diversity must also be respected (Declaration, s/a).

Thus, genetic interventions, in the context of assisted human reproduction, must contemplate the diversity and naturalness of the manifestation of the genetic heritage, making biological manipulations that are detrimental to the integrity of the genetic heritage and, consequently, to the human genome, in an attempt to carry out eugenic practices, which offend human dignity.

## **6 Conclusion**

In the contemporary world, the problems related to infertility and/or infertility have been mitigated, or even solved, with the help of biotechnology, which began to allow infertile individuals or couples, as well as single-parent, coparental and homoaffective families to generate biologically compatible children and without the need to practice the sexual act. Infertility then came to be seen as a pathology capable of being ruled out in the face of medical science and assisted human reproduction techniques.

In this scenario, in which the set of methods and instruments of assisted human reproduction enables free family planning, the Brazilian legal system is incapable, in view of the scarcity of specific legislation, of adequately supporting the theme, while the reflections

that permeate the use of preimplantation genetic diagnosis, especially when based on artificial intelligence, tend to cause numerous controversies of an ethical, moral and legal nature.

With a lack of national legislation that regulates the limits of assisted human reproduction, Resolution No. 2,168/2017 of the Federal Council of Medicine will guide these procedures, although it has a merely deontological and administrative character, not serving, *prima facie*, as a normative instrument required in the legal sphere. Therefore, it does not present legal sanctions aimed particularly at the practice of such medical interventions.

On the other hand, with regard to preimplantation genetic diagnosis, Law No. 11,105/2005, Biosafety Law, offers some legal support, prohibiting genetic manipulation in living organisms or even *in vitro*, whether in germ cells, zygotes, or human embryos, according to its article 6. Despite this, there is insufficient Brazilian legislation to regulate and establish clear ethical and legal limits in the application of the diagnosis.

From this perspective, it was found that this type of technique, when used for non-therapeutic purposes, enables the so-called liberal eugenics, which directly affronts the Federal Constitution, in particular, its article 3, item IV, which prohibits any and all forms of discrimination, in this case, that of genetic origin.

The fact is that artificial intelligence, when used in the aforementioned diagnosis indiscriminately, performs an optimization of the genetic selection of the embryo, in a true objectification of the human being, resulting in genetic discrimination by determining which genetic characteristic fits as superior or inferior. In this regard, there is no doubt that biotechnology challenges not only nature, but the human being himself in his molecular structure, so that the human genetic heritage should not be subordinated to a "will of will". Since different thinking would lead to the total vulnerability of the being. The way out, therefore, is to understand that embryonic diagnoses should be made with the justification of a therapeutic order only, moving away from any purpose of an "perfecting" or "enhancing" nature.

A different understanding directly affronts the principle of the dignity of the human person, the normative and axiological epicenter of the legal system, which sees man as an end in himself and insusceptible to instrumentalization, which, in the embryonic field, can be visualized when clinical experimentation for preimplantation diagnoses outside the therapeutic purposes. Thus, genetic interventions in assisted human reproduction must contemplate the diversity and naturalness of the manifestation of the genetic heritage, making biological manipulations that are detrimental to the integrity of the genetic heritage unfeasible.

Therefore, the mere availability of technological means that enable the reach of offspring, and even the screening of genetic pathologies, does not authorize or unrestrictedly legitimize all forms of their use. They must be analyzed so that there is no disrespect and violation of the fundamental rights of the future child, especially the dignity of the human person, in order not to instrumentalize the human body, according to the Habermasian perspective.

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