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КРИОНИКА: ОРГАНИЗАЦИОННО-ПРАВОВЫЕ И ЭТИЧЕСКИЕ АСПЕКТЫ

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Работа посвящена крионике как области научно-практической деятельности, занимающейся заморозкой людей с целью восстановления их жизнедеятельности в будущем при помощи соответствующих технологий. В статье рассматриваются проблемы организационного характера, связанные с деятельностью криофирм на мировом рынке. Поднимается проблематика, связанная с правовым аспектом крионики, который выражается в отсутствие нормативно-правовых актов, регулирующих положения и деятельность только кампаний, занимающихся криоконсервацией. Обращается внимание на этическую составляющую крионики. Приводятся аргументы противников и сторонников крионики. Предлагаются средства и методы для решения насущных проблем, связанных с криоконсервацией человека, деятельностью крионических фирм и малой распространенностью идей крионики в современном обществе.

Ключевые слова: крионика, криоконсервация, крионический биостаз, криобиологические методы, витрификация, криопротекторы, криопациент, крионические организации, договор, услуги по криоконсервации, рынок крионических услуг, правовые и этические проблемы криоконсервации.

CRYONICS: LEGAL AND ETHICAL ASPECTS

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The article is focused on cryonics as a field of scientific and practical activity dealing with freezing humans and aiming to resuscitate them in the future through applied technology. This article discusses organizational problems relating to activity of cryonics companies on global market. It also shows legal issues of cryonics with absence of legislation that regulates only terms and conditions of cryopreservation companies. Then, it shows ethical aspect of cryonics, arguments of supporters and opponents of cryonics. The article offers means and methods of solving immediate problems relating to cryopreservation of humans, activity of cryonics companies and little awareness of cryonics ideas in modern society.

Key words: cryonics, cryopreservation, cryogenic biostasis, cryobiological techniques, vitrification, cryoprotectants, cryopatient, cryonics organizations, contract, cryopreservation services, cryopreservation market, legal and ethical issues of cryopreservation.

The concept of cryostasis was formed in 1940s and 50s dueto scientific achievements in cryobiology, neurobiology, molecular biology, and informatics. Under the name of cryonics, cryostasis was put into practice in the USA in the late 1960s. Cryonicsis low-temperature freezing of a human corpse, with the hope that resuscitation may be possible in the future when the required technologies will become available [3]. The best way of preserving human body known to the date is stopping the process of decomposition in the body, which occurs naturally while deep-freezing. Vitrification is used for preserving human body. Vitrification is cryopreservation with the help of special next-generation cryoprotectant mixtures and effective temperature controlled processes, which fully eliminate tissue freezing. As a result, patient's tissues do not freeze (as many people not so familiar with cryonics think), but become hard as glass without formation of ice crystals. Moreover, living cells are able to stay alive after vitrification. This ability occurred naturally during evolution process. It is necessary to fix the fine structure of human brain (spatial distribution of connections between neurons) during several hours (or even several dozens of hours) after organism death. In this case, information about the person's identity that was saved would be enough for their future medical revival (of course this includes saving past memories too). Cryonicsdoes notgive a 100 % guarantee for revival, but it is the only real way to reach immortality for many people.

Cryostasis is part of cryonics and is fixing tissue structures of human body through freezing to extra-low cryogenic temperatures [10].

For cryostasis, chemicals known as cryoprotectants are infused into body through circulatory system to reduce freezing damage for tissues. Then the body is gradually frozen to the temperature of liquid nitrogen (-196°C) and placed into a liquid nitrogen cryostat (dewar or big thermos). At such extra-low temperature, it can be preserved for centuries virtually unchanged. However, as liquid nitrogen tends to evaporate from a dewar, it should be added there periodically. This makes the process of preservation rather expensive.

Existing cryobiological techniques allow microscopic animals (up to several mm long) to freeze to liquid nitrogen temperature with minimum damage. After this, they thaw and continue functioning in a usual way. At a temperature from -5 to -50°C some insects (like maggots and caterpillars of Palaeartic butterflies), amphibians (frogs and Siberian salamanders) and reptiles (turtles) freeze and then revive after thawing. Skin, cornea, bone marrow, sperm and embryos are frozen to the temperature of liquid nitrogen for storing and future thawing and medical use. In small pieces of adult human brain tissues, electrical activity of neurons can be seen after freezing and thawing.

There is massive work being done in the field of freezing separate human organs. In the next 10-20 years, it is expected that promising cryobiological techniques for safe freezing and revival of a whole brain are going to occur. This indicates that during freezing with cryoprotectants damages got by a biological subject at molecular or cellular level are not lethal. Main damages that make it now impossible to freeze and then revive a human occur while freezing big biological objects on organic and tissue level because of complexity of tissues and organs and different volume of cryoprotectants in them including even lack of cryoprotectants in some parts. This causes gradients of concentration of chemicals and mechanical stress, which lead to cell membranes damage, and fractures in tissues and organs. These damages are numerous, but they do not lead to permanent loss of information about organism structure, so they can be repaired in the future.

Today it is impossible to describe exactly the whole spectrum of technologies used for reviving cryopatients in the future. Still, with scientific progress the understanding of them becomes fuller. Today we can assume that such technologies like nanotechnologies, organs growing, artificial organs (cyborgization), brain modeling, 3D printing of organs and tissues, organ transplantation (and other technologies that are not widely used today) may be used for revival.

Cryonics deals with finding ways of long-term preservation of people with serious diseases or deceased ones with use of nanotechnologies as part of scientific and commercial practice.

The aim of cryonic biostasis is preservation of terminally ill patients until the times when medical technologies become able to cure damaged cells, tissues and pathologically changed functions of organism. In special cryonic organizations, the process of cryostasis goes through some stages from signing a contract and becoming a member of a cryonic organization to cryopreservation, storing and revival with further treatment.

Arguments provided by companies offering cryopreservation of a whole body or its parts seem to be quite attractive, as they promote an idea that not only a body, but an identity, consciousness and even individuals may be safely frozen and revived with no consequence. It is also expected that there will be an option of resurrecting deceased people and brain transplantation.

The patient may choose between the whole body preservation and preservation of only its part, i.e. neuropreservation. Neuropreservation is preservation of brain only or the whole head at extremely low temperatures. Neuropreservation may usually be interesting to people who are well-acquainted with new technologies and tech & scientific predictions. Neuro-preservation is an option for those who understand

that according to modern scientific views identity of a person is in the brain – and also for those who expect that in the future a patient will get a newly-grown body as a set of organs (for example, from the stem cells of this patient) – or an artificial one [11].

In modern world there are several companies providing cryopreservation services and having their own cryostorages. Alcor is an American nonprofit organization founded by Fred and Linda Chamberlain in 1972 in California with the name Alcor Society for Solid State Hypothermia (ALCOR). Cryonics Institute is an American nonprofit organization founded in 1976 by Robert Ettinger and co [12]. KrioRus is Russian cryonics company founded in 2005 as a project by a non-governmental organization Russian Transhumanist Movement that promotes transhumanism and immortalism, studies the perspectives of developing innovative technologies, and develops them. Yinfeng Life Science Foundation is a Chinese organization founded in 2017.

KrioRus is the only cryonics company in Europe that possesses its own cryostorage and offers full range of cryonic services. According to official KrioRus site, by 2018 they have 66 cryopatients and 31 cryopreserved animals. About 200 people have already signed cryopreservation contracts. Today, KrioRus stores 19 foreign citizens of Ukraine, Italy, USA, Australia, India, France, Republic of Belarus, Georgia, Estonia, Israel, Netherlands, Switzerland and Japan [13]. The cost of neuropreservation is \$15,000 for Russians and \$18,000 for foreign clients. All procedures are the same for both whole body and neuropreservation, except that for whole body, perfusion and storage become more complicated and costly. So the fees for cryopreservation of cryopatient's entire body are currently \$36,000.

KrioRus enters contracts with clients that establish subject matter, main terms on cryopreservation, obligations of the parties, duration of the contract, contract termination terms, guarantees and liabilities. The subject matter of a contract is a person willing to become a cryopatient who specified that in a will. The contract agreement says that implementing party performs its actions only after registration of patient's legal death. Also the implementing party should be notified in advance about critical condition of a cryopatient. KrioRus undertakes to organize all required transport activities for a patient and immediately start the required procedures, and also to ensure safe cryopreservation. The customer must pay for the service in accordance with a contract; take measures for making Declaration of Intention of cryopatient's desire to be cryopreserved and immediately inform KrioRus about critical condition of a cryopatient. Also the customer is obliged to coordinate with KrioRus the amount of information about cryopatient, that could be used by KrioRus in informational materials. The implementing

party does not guarantee revival and successful preservation of a cryopatient. This can be found in multiple clauses of a contract, but KrioRus agrees to fulfill the obligations in good faith. KrioRus is not responsible for cryopreservation of a cryopatient at locations other than the facilities the company is using. KrioRus declines all responsibility for delay in performing or failure to perform the obligations caused by force majeure circumstances beyond company's control. Duration of a contract is 100 years, from the moment of signing. If the possibility of reviving cryopatients does not appear during the term of the contract and in the absence of violations of the contract, the contract is automatically prolonged for another 25 years each time.

You must become a member of Alcor to enter a cryopreservation contract with this company. The Membership Due is \$700 a year. Today cryopreservation of a whole body costs \$200,000, and neuropreservation costs \$80,000. Non-members of the organization also have an option to enter a cryopreservation contract agreement. In this case you should pay additional \$25,000 for cryopreservation of non-members organized by third party being a member of Alcor or \$50,000 for cryopreservation of non-members organized by third party being a non-member of Alcor too. On September 30, 2018, there were 162 patients of Alcor and 1214 organization members.

The Cryonics Institute (CI) does not offer neuropreservation – only cryopreservation of the whole body. This is mainly because CI specialists consider the idea of preserving only a patient's head unacceptable for most people. In July 2018, there were 170 patients, 158 animals and 1898 members in CI.

Cryopreservation contract agreements with CI and Alcor have little differences between each other. The procedure in Alcor is as follows. Signing a cryopreservation contract, a person automatically becomes an organization member and has to pay membership dues. This is due to legislation of the USA and legal status of this organization, which members are its managers at the same time. You can become a lifetime member or a yearly member. In a cryopreservation contract, there are duties of the parties, provisions explaining the cryopreservation process and risks involved. The member must not only sign the cryopreservation agreement, but also sign a consent for cryopreservation and provide last will and testament for human remains and Authorization of Anatomical Donation. Alcor shall maintain all required efforts for successful cryopreservation of a member and will make reasonable efforts to protect the name of the Member in conjunction with details of his/her cryopreservation, if only the member allows to publicly disclose the information. The agreement must be signed not only by a member, but also by 20 other

members of Alcor and witnesses. It is also possible to become an associated member of Alcor. These supporters of Alcor are not yet ready to make cryopreservation arrangements. Associate Members are members of the Alcor Life Extension Foundation who have not made cryonics arrangements but financially support the organization.

The companies do not guarantee that there will be a safe human reviving technology in the future. When signing a contract with KrioRus agreeing to conduct scientific research on preserving and reviving a human, KrioRus requires patient's recognition that the company does not guarantee reviving a cryopatient.

After being notified about the death or critical condition of the cryopatient, the cryonic company sends a team of cryonic experts to the location of the cryopatient. After getting a death certificate, this team starts preparing client's body for cryopreservation (by perfusing body tissues with cryoprotectant agent, starting gradually cooling the body and transporting it to the cryostorage). After the freezing is finished, the body is placed into a cryostat of Dewar vessel type with liquid nitrogen [1, C. 173].

The practice of reviving a body of a diseased or dead person which was being cryopreserved for future treatment for decades or even centuries now seems fantastic. For these ideas to become true, the scientific world of biophysicists, biologists, doctors, lawyers, philosophers and other specialists should solve many problems, some of which should become a basis for planning of future scientific research.

While reviving a frozen body, there may be a need of own or someone else's blood or its components. With blood transfusion from one person to another, the recipient also gets information of another person. There has been limited research on this issue, but it is very important from the point of view of medicine and cryology.

From a scientific perspective, we should answer a question of when the human body should be cryopreserved. In fact, changes in brain cells and other tissues start to develop after 5–7 minutes of clinical death. These changes are considered irreversible and defined as biological death.

Cryonics is legal in most parts of the world. It is illegal only in British Columbia in Canada. The legislation prohibits cryonics promotion, but does not prevent residents of British Columbia to enter into contracts with cryocompanies outside the province. Employees of funeral homes may transport cryopatients to cryocompanies outside the province.

There is still no legislation regulating terms and issues of cryonics only. Organizations providing cryopreservation services act under general law.

Alcor and the American Cryonics Society operate under The Uniform Anatomical Gift Act (UAGA), which allows them to receive human organs and possess

them. After at least three trials in California Alcor got a right to provide cryopreservation services in this state and UAGA provided Alcor with quick access to patients' remains in hospitals. As American Cryonics Society is also based in California, it got some benefits from Alcor legal victories in court.

CI has a cemetery license, which under the laws of the state Michigan allows them to be considered a cemetery. It also receives organs for ACS (American Chemical Society).

In Russia, cryonics is legal. People have right to determine the terms of storing their body after death. Preservation of frozen body or brain for scientific purposes is not prohibited in Russia. Cryonics is also a part of scientific experiment.

Limited liability partnership KrioRus is a research organization which according to its Company Charter and Federal Law «On science and federal technical and scientific policy» may conduct scientific research and experiments, including cryonics field [6].

Russian civilistic science did not consider the issue of legal framework of cryopreservation as a form of burial. The Article 1 of 12.01.1996 Federal Law «On burial and funeral business» (next seen as FL «On burial and funeral business») establishes guarantees of burial of a deceased person regarding his/her wishes expressed while alive and the relatives. Law determines burial as a ceremonial act of burying a corpse in accordance with customs and traditions, which do not violate health-related and other requirements (Article 3 of Federal Law «On burial and funeral business») [7].

Technical and scientific achievements in the field of cryopreservation tend to increase. Development of social relations needs to be legally settled in a proper way. Some scientific literature states that law is valuable because of its ability to regulate social relations the best way, so non-social law in this context cannot exist [2, C. 112]. Due to this, one should consider issues of legal regulation of cryopreservation from the point of view of their social necessity.

In accordance with the Article 66 of the 21.11.2011 Federal Law «On the Bases for the Protection of the Health of Citizens in the Russian Federation», «the moment of one's death is the moment of their brain's death or their biological death (irreversible death of an individual). Brain death happens with complete and irreversible cessation of all its functions registered with heartbeat and artificial ventilation» [8]. Ministry of Health order of 25.12.2014 «On procedure of establishing the diagnosis of brain death of an individual» (registered in the Ministry of Justice of the Russian Federation 12.05.2015, № 37230) sets out the rules of establishing a diagnosis of human brain death, including children aged one year or older, in medical institutions or another institutions practicing medical activities regardless of their legal status.

These rules are regulated by Federal Law «On the Bases for the Protection of the Health of Citizens in the Russian Federation» [9]. Brain death thus equals death of an individual.

Most legal cases show a conflict between cryopatient's will expressed in his/her testament and their family. Sometimes relatives who do not understand or accept the idea of cryopreservation refuse to carry out the cryopreservation contract and take the body of the deceased for further burial or cremation. For example, on November 22, 2012, the appeal judgement of Moscow City Court declines to admit body release of citizen M.A. to the citizen O.V illegal, declines obligation for the company «Ritual» to transfer the body to the «KrioRus» company and to impose penalty. The only reason for this decision was that this controversy is not decided by the ordinary court. In foreign court practice, there is a case where a cryopreservation company proved its case. On May 12, 2010, the Iowa Court of Appeals ruled in favor of Alcor and ordered to continue cryopreservation of Orville Richardson's remains. The court also ordered that the UAGA, which is applicable in Iowa, may be applied to Mr. Richardson's written wishes about cryopreservation by Alcor, so Alcor's demand regarding the remains is above the demand of brothers and sisters who embalmed and buried Mr. Richardson.

As a young scientific practice, cryonics deals with many ethical problems. Its problems may be considered as bioethical. Bioethics is a field of interdisciplinary research aimed on reflecting, discussing and dealing with moral issues brought up by the latest achievements of biomedical science and healthcare practice [5, C. 5]. It is aimed to manage conflicts between the field of developing and implementing new biomedical knowledge and technologies at one end and individuals and society at the other. Bioethics goes beyond medicine. As an applied science, it tries to solve problems arising in modern clinical practice, such as very specific ethical tasks resulting from appliance of the latest technologies dealing with the beginning and the end of life. Not only may the cryopatient suffer from some kind of harm, but also the relatives. If the process of cryopreservation or storing the patient went wrong, it would become impossible to revive him/her in the future. This may affect not only the patient whose last will was not executed, but also his family. Failed or interrupted cryopreservation may make them feel guilty about their beloved one. Moral damage may also be expressed in uncertain status of the cryopatient, lack of columbarium or a place for mourning.

It must be noted that scientists tend to think that «freezing a body and its storage for an uncertain period of time with the hope that future generations will be able to bring it back to life is an act of faith, not science». President of National Council Against

Health Fraud William T. Jarvis expressed conventional wisdom of doctors: «Cryonics might be a suitable subject for scientific research, but marketing an unproven method to the public is quackery». Doctors often ignore cryonics considering it fun, but expensive and risky [14].

«Global science acknowledges that frozen human bodies cannot come alive. That's why Russian doctors treat cryonists like healers, pseudoscience popularizers», – says Irina Siluyanova, head of the bioethics department of RNRMU. «Today we can freeze and restore individual cells (including very important ones like ovules and sperms), separate organs and some simpler organisms like reptiles, – claims Evgeniy Aleksandrov, the head of Commission on Pseudoscience of Russian Academy of Sciences. – But cryonics is merely exploiting our fear of death. I can't imagine a physiologist who truly believes it is possible to revive frozen people in some distant future. I think of the company's activities as of business with fraudulent elements».

This is what cryonics opponents say, believing all this is unreal, useless and senseless. They often appeal to the incomplete process of cryopreservation, global problems like overpopulation and lack of resources and consider cryonics companies activities to be mere fraud. The supporters of cryopreservation do not agree with this offering arguments in favour of cryonics. Cryonist Eliezer Yudkowsky says, «Effective cryonics saves exact all the same what is saved when you fall asleep and then get up the next day». Alcor representatives say, «It's silly to single out something as small and speculative as cryonics as a population issue. Life spans will continue increasing in developed parts of the world, cryonics or not, as they have done for the past century. Historically, as societies become more wealthy and long-lived, population takes care of itself. Couples have fewer children at later ages. This is happening in the world right now. The worst population problems are where people are poor and life spans short, not long». Cryonics supporters also say that latest technologies have always been unacceptable for general public. The same situation was around organ transplantation, but now it is normal and necessary for saving one's life. Moreover, cryonists think that there will be no changes in long-term memory if the cryopreservation is made accurately. There was an experiment with nematode *Caenorhabditis elegans*, a very well-known model organism for biological research that has generated revolutionary findings. The results in testing memory retention after cryopreservation show that the mechanisms that regulate the odorant imprinting (a form of long-term memory) in *C. elegans* have not been modified by the process of vitrification or by slow freezing [4]. This means that theoretically even after

reviving a person in the future their identity will not be lost.

While observing cryonics companies activities more deeply, the problems with cryopreservation become evident. This is due to lack of information about cryonics techniques for masses. An ordinary person does not understand the process of freezing because he/she does not know all its nuances. Also, considering the fact that all cryonics companies abdicate their responsibility and do not guarantee successful cryopreservation and future reanimation, the customer may fall into complex situation when he gives his money and body for the technology, which probably will not be performed properly. So one might draw to a conclusion that possibly cryonics is just a business competing mortuary services. This is another problem showing imperfection in legal regulation of cryonics in the world and raising people against it.

Today the important question is, what activities are required to make cryonics not look like pseudoscience? The answer is complex. First, it is necessary to create legal framework for cryonics, which should regulate all stages of cryopreservation. Ethic committees should be established in cryonics companies. Through legislation it is necessary to develop procedures obliging medical institutions to assist cryopreservation companies in carrying on patient's last will. It is also important to spread the ideas of cryonics through media and that way inform people about this technique and an alternative to death. From our point of view, if one wants to decide in favor of cryonics credibility, they should competently examine its scientific basis (because many basic assumptions are built on scientific theories and hypotheses and analysis of science development perspectives, not on experimentally established facts) in some pretty different scientific areas as neurobiology and neuropsychology, cryobiology, emergency medicine and thanatology, nanotechnology (or atomic and molecular physics), molecular and cell biology, informatics. Despite cryonics still being imperfect because the safe human reviving technology is not developed yet, it is necessary to enhance its development. This will help to cure many non-infectious chronic diseases and allow patients to improve the quality of their life in the future.

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