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THE MAIN ETHICAL ISSUES WITH NANOTECHNOLOGY IN THE FUTURE CONTEXT

Summary. This paper focuses on defining the main ethical issues with nanotechnology. Its aim is to outline possible ethical risks, which we systemize according to the individual phases of existence of nanoparticles. Examples may be the violation of privacy, violation of a person's autonomy, environmental pollution, and so on. The result is a clear schema of questions, which should consequently be solved by means of the applied ethics, where we point out at the most acute issues from the future point of view of, as well.

Keywords: applied Ethics, nanotechnology, risks, toxicity responsibility.

GLÓWNE ZAGADNIENIA ETYCZNE ZWIĄZANE Z NANOTECHNOLOGIĄ W KONTEKŚCIE PRZYSZŁOŚCI

Streszczenie. Artykuł ten skupia się na określeniu głównych zagadnień etycznych związanych z nanotechnologią. Jego celem jest określenie możliwych zagrożeń etycznych, które należy usystematyzować według poszczególnych faz istnienia nanocząstek. Przykładem może być naruszenie prywatności, naruszenie autonomii człowieka, zanieczyszczenia środowiska itd. Wynikiem jest jasny schemat pytań, które w związku z tym powinny być rozwiązane za pomocą etyki stosowanej. Zwraca się w nich uwagę na najtrudniejsze problemy, także z przyszłego punktu widzenia.

Słowa kluczowe: etyka stosowana, nanotechnologia, ryzyka, toksyczność, odpowiedzialność.

1. Nanotechnology and its practical use

Nanotechnology may be defined as “the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications. Encompassing nanoscale science, engineering, and technology, nanotechnology

involves imaging, measuring, modelling, and manipulating matter at this length scale.¹“ This technique is mainly based on the use of the new characteristics of substances, gained by mechanical regrouping of atoms. Its results are used in various fields – garment industry, automotive industry, construction industry, as well as in medicine. In practice, we encounter contrast agents created using nanobase, or drugs more efficient in carrying the active substance, nowadays. The application of nanotechnology is interdisciplinary and may be classified within the field of nanomaterial, nanochemistry, nanoelectronics, nanooptics, nanoproduction, nanoanalysis, and nanobiology². There is a high number of potential uses and the experts are constantly working on new possibilities. This not only results in an increasing number of new alternatives, but also in new moral risks.

At present, discussions on ethical aspects of nanotechnology are under way, the main topic being the risks arising from its application. These discussions are rarely taking all the complexities into consideration systematically. They usually consider only one ethically debatable aspect of the nanotechnology. While dealing with moral dilemmas related to this relatively new scientific discipline, a systematic approach is necessary. It will not only make the topic more systematic, but also demonstrate the complex nature of nanotechnology. This is important for choosing an approach to be used when applying ethics. Last but not least, the clarification of all ethical aspects of nanotechnology is necessary to prevent moral issues, which will be more perceptible in the future.³

2. Current moral issues in the field of nanotechnology

When defining current ethical issues related to nanotechnology, we have considered appropriate to systemize them in a similar way as it was done during the project NanoDiaRA (Nanotechnology Based Diagnostic Systems for Rheumatoid Arthritis and Osteoarthritis), during which the ethical aspects accompanying the development of nanomaterials in medicine were defined; covering all the phases from development through production, sale and application to disabling⁴. A well-arranged draft was created in the framework of the *Ethical, legal and social implications program* (ELSI). Ethical aspects of nanotechnology in general can also be outlined in this way, regardless of the field, where they are used, while considering other, new aspects.

¹ NNI, 2004. Strategic Plan: výskumná správa. Arlington : NSET, p. iii.

² Prnka T., Šperlink K., 2004, Nanotechnologie. Praha : ČSNMT, p. 68.

³ Examples might be the Nanoethics magazine, the European Parliament, National Nanotechnology Initiative, etc.

⁴ Thiele F., Mehlich J., 2012, Nanoparticles for medical purposes – Technical, medical and ethical aspects: research report. Bad Neuenahr-Ahrweiler : Europäische Akademie, p. 1.

In the preliminary phases, in particular during the planning of nanotechnology application, an ethical question arises of to what extent it interferes with the integrity of humans beings or nature. Owing to nanotechnology, we may consider taking actions enhancing the human body, or interfering with environment in a considerable way. In this case, it is important and difficult to define the scope of control, since it requires defining strict limits without limiting the freedom of choice of an individual. However, it is necessary to realize that the moral issue in question has also to do with the opposite case: “Nowadays, an opposite case resonates – decreasing abilities of living organisms.⁵” For instance, it is related to limiting the ability to feel pain using nanotechnology in order to breed animals in unsuitable conditions.

The ethical questions related to the process of research and testing nanotechnology include probably the most pressing issue – the toxicity of some nanoparticles. For example, nanoparticles can penetrate blood-brain barrier; but there are differing views on the harmfulness of this process. Some experts, however,⁶ point out the fact that, as a result, the nanoparticles may accumulate in the bodies of living organisms and cause complications. On the other hand, nanocolloids do not tend to settle, and because of that their concentration in the air may not change in nature, what increases the probability of contamination. The question of defining conditions for responsible research arises, and a lot of nanoscience activities are not subject to strict ethic scrutiny, with regard to the new risks.

Nanotechnologies, which are being tested, are not only connected to new ethical problems. In the research of nanomaterials, similarly to other areas, the issue of animal testing is problematic, as well. During the research on the consequences of the nanoparticles for an organism, different mechanisms are frequently introduced into the living bodies of laboratory mice, which causes them pain or death. Animal rights activists are objecting to such treatment and emphasize animals’ right to live and exist without pain. Their opponents are defending scientists, who do not have other options to test potential medical tools without harming humans.

The ethical issues also include the problem of the intellectual property of a nanoscientist, who encounters problems with patenting. Particularly in countries, where a “possibility to register a patent 6 – 12 months after the publication of results does not exist, including Slovakia, the chances to get a patent disappear due to competitive interests of the researcher to publish.⁷”

During the production of the conveniences of nanotechnology, a question arises of how to ensure that they are not being reduced to an object of enrichment for companies that might not pay attention to the moral dimension of the nanotechnology application. At present, we see products containing nanoparticles appear on the market without having to comply with

⁵ Luby Š., Lubyová M., 2014, Etické implikácie nanovedy a nanotechnológií. In Sociálne poslanstvo Jána Pavla II. pre dnešný svet. Ružomberok : Verbum, p. 91-99.

⁶ White G.B., 2009, Missing the Boat on Nanoethics. In American Journal of Bioethics, vol. 9, no. 10, p. 18-19.

⁷ Luby Š., Lubyová M., 2014, Etické implikácie nanovedy a nanotechnológií. In Sociálne poslanstvo Jána Pavla II. pre dnešný svet. Ružomberok : Verbum, p. 95.

control criteria or without containing warnings. While individual companies embrace the dimension of responsibility, we need an engagement of the governments and other public stakeholders, but there is a question of who is responsible for the decisions in this area.⁸

Other ethical problem related to the sale of nanotechnologies, is a privilege of the rich, who can afford better healthcare and products of higher quality. In this case, the key moral category is justice and it is necessary to define criteria for the redistribution of the conveniences of nanotechnology.

When introducing nanotechnologies into the practice, we may encounter moral issues arising from the need to inform the public. Considering some of the unpredictable consequences of nanotechnologies, it is complicated to provide users with the relevant data, and it is not possible to impose a moratorium until we understand all the dangers, because a lot of countries have already invested a lot of financial resources in the nanotechnology industry.⁹ Therefore, it is arguable to what extent the unresearched innovation should be used and how to inform the consumers. The problem is more visible in the areas, where the informed consent for the use of nanotechnology is needed, for example in some spheres of nanomedicine. In this context, it is necessary to mention another ethical dimension of nanotechnology, since its users can influence their health condition or capabilities. Liberty is directly proportional to the level of responsibility and it is necessary to define a framework to determine the admissible activities in this area.

In connection with the tracking devices on the nanobasis, we start to talk about risks of invasion of privacy and a need of a new paradigm. It does not only apply to the tracking of a person's position, but also to a greater access to the health data, thanks to a new type of electronic cards.

In the context of nanoproducts disposal, we may talk about moral issues connected with responsible removal of the dangerous substances. It is important to establish an effective control by individual governments and it is also appropriate to emphasize prevention.

3. Ethical questions of nanotechnology in the future context

The vision of ethical issues with the progress in nanotechnology is often connected to the invasion of independent machines, intervention into the human body, changing its core, or transhumanism. If we want to talk about future moral questions of nanotechnology, we may generally divide them into three groups: ethical risks expected in the coming years, future options, which are relatively far away, and risks created in our fantasy. "The public fears may

⁸ Among these products, we may cite impregnation spray for booths, various parts of clothing containing antibacterial silver nanopartiles, paints for buildings and so on.

⁹ Litton P., 2007, "Nanoethics"? What's New? In *Hastings Center Report*, vol. 37, no. 1, p. 22-25.

be divided into the science fiction category, including fear of autoreplicating systems and uncontrollable robots, and real risks, e.g. new biological weapons, toxicity of nanomaterials, molecularly naked patients, privacy invasion.¹⁰ These options could be classified into the category of the so-called imminent ethical risks, which will need to be addressed. The above-mentioned increase in toxicity is directly proportional to the advance in time because the increasing possibilities of the nanotechnology application will increase the risk of pollution and contamination. We can mention other risks as well.

An important task, which should be the first step in solving moral issues of nanotechnology, is the definition of subject and purpose of nanoethics. In the same way that nanotechnology is a result of interdisciplinary cooperation (often called NBIC technologies, i.e. nanotechnology, biotechnology, information technology and cognitive science), in dealing with ethics of nanotechnology the cooperation of several fields is necessary. At present, it leads to discussions on the legitimacy of nanoethics as an independent and interdisciplinary branch of applied ethics. The supporters of this concept refer to the qualitatively new ethical problems with nanotechnology. Opponents argue these problems are old, dressed up in the modern clothes.¹¹ Such a lack of clarity results in inactivity when dealing with the current and future ethical risks of nanoworld, initiatives being rare. The responsibilities are not defined clearly and those involved in the moral dilemmas are not aware of possible solutions.

The properties of nanoparticles, such as large surface area and reactivity and small size, result in properties different from those of bigger particles.¹² This change in substance properties, which is mapped in detail, causes concern about the new, unknown risks that cannot be prevented nowadays. For this reason, it is necessary to create a scientific area in order to research specific properties of nanotechnologies, and put the emphasis on the detection of toxicity¹³, since the current tests might be ineffective, being designed to detect the safety of the traditional materials, not nanomaterials. They could show admissible values, while the overall effect on the human health might be destructive.

The nanotechnology opens up possibilities to solve some of the problems in developing countries. Using nanomaterials, we will be capable of providing healthcare of higher quality, obtain the natural resources in an easier way, or increase the standard of living. The first question arising in this case is the question of moral authority of the developed states to intervene in the problems of other countries. The research directed in this way might be targeted appropriately, but the right for independence and avoidance of utopism have to be preserved. The next type of risk is that the use of nanotechnology might become dependent on

¹⁰ Luby Š., Lubová M., 2014, Etické implikácie nanovedy a nanotechnológií. In Sociálne poslanstvo Jána Pavla II. pre dnešný svet. Ružomberok : Verbum, p. 93.

¹¹ McGinn R.E., 2010, What's Different, Ethically, About Nanotechnology?: Foundational Questions and Answers. In NanoEthics, vol. 4, no. 2, p. 115-128.

¹² Myhr A.I., Dalmo R.A., 2007, Nanotechnology and risk: What are the issues? In Nanoethics: The Ethical and Social Implications of Nanotechnology. New Jersey : John Wiley & Sons, p. 149-159.

¹³ In this work, we have dealt with this question in detail: Ethical aspects of nanomedicine : diploma thesis. Banská Bystrica : UMB, 2014. p. 59.

the wealth of countries. The solving of the issue of distributive justice is therefore becoming necessary in the broader context as well. With the deepening of poverty in developing countries, we may soon talk about ethical problem with the nanotechnologies on a global scale. This might lead to unfair distribution of NBIC technologies, because developing countries will simply not be able to afford them, even though they would solve their poverty. This results in question of developing a functional framework, in which the progress would take place, and which would emerge from ethical criticism and controlling.

4. Selected options for solving ethical problems with nanotechnology

When solving the ethical problems mentioned, it is necessary to emphasize the meaning of interdisciplinary approach. Some questions require cooperation of professionals in the realms of the natural science and humanities. That is why we need interaction of physics, chemistry, mathematics, biology, engineering, philosophy, ethics, economy, law, sociology and so on. By interaction we mean the understanding of common methods and elaboration of the given area of nanoethics (in this context, it is difficult to define unified applied ethics, dealing with the nanoethical problem, because the above-mentioned questions fall within bioethics, ethics of science, ethics of technology, business ethics and so on). Other important part of nanoethics elaboration is an exchange of the relevant information (experts on natural science may draw the attention to the reality of visions), ensuring the elaboration of appropriate recommendations for the spheres in question (in the case of applied ethics, it is adequate to determine the scope of responsibility of the individual stakeholders, for instance), and the subsequent application of nanotechnology by means of a functional framework. During this process, the applied ethics could contribute to ensuring ethical standards of the use of nanotechnology, because the “applied ethics are striving for elaboration of a set of ethical methods, methodology and tools related to its practical use. An important scientific and pedagogic aim of applied ethics is to teach and develop inter- and transdisciplinary method for its aspirants and in its activities.”¹⁴

Other important aspect of dealing with moral problems of nanotechnology is the succession. If we do concentrate on solving the most pressing issues, later on, it might help us solve those, which seem to be the most difficult, but are not urgent from the point of view of time. Global Challenges Foundation has defined twelve risks threatening human civilization. They have also cited nanotechnology, and the key factors important in estimating its impact are:

- timeline of nanotech development;
- progressing aspects of nanotech research;

¹⁴ Fobel P., 2010, Aplikovaná etika ako akademická a praktická perspektíva. In Aplikovaná etika vo vzdelávaní a praxi. Banská Bystrica: Univerzita Mateja Bela, p. 20.

- capacity of small groups to assemble a weapons arsenal;
- defensive use of nanotechnology;
- possibility of being outside human control.¹⁵

National Science Foundation¹⁶ also mentions some phenomena in the nanotechnology, which should be considered before their further use. They include uncontrolled consumption of natural resources, life-threatening as the “side product” of the nanotechnology, machines working independently from humans, machines taking over human characteristics and the production of weapons of mass destruction. The above-mentioned phenomena need to be assessed from the ethical point of view.

Last but not least, the negative consequences of nanotechnology might be eliminated by raising public awareness about the findings of the investigation of moral risks. On one hand, it may decrease the amount of illegitimate concerns, on the other hand, it may increase safety and responsibility of the consumers.

Conclusion

A brief systemization of the ethical problems of nanotechnology causes risk of insufficient penetration into some of the questions and of forgetting about some important aspects. In my paper, I have attempted to present the most current ethical problems in nanotechnology that should be solved the soonest.

Nanotechnologies are beneficial for a lot of areas of their application. For example, the cultivation of new organs for patients, materials of higher quality that are, consequently, safer for various uses, promotion of sustainability and so on. For these reasons, it would not be wise to assume that the nanotechnology brings only threats that should be dealt with. We are talking about the products that have both positive and negative sides. That is the case with the inventions (e.g. automobiles, weapons, and so on) which are being used nowadays, however, we do realise their risks and try to eliminate them. It is important to define the specifics of nanotechnologies as soon as possible, be cautious and then take action to reduce risk. The given model represents a responsible approach to these new technologies enabling people to take advantage of their existence.

¹⁵ Armstrong S. et al., 2015, Global Challenges: 12 Risks that threaten human civilisation. Stockholm: Global Challenges Foundation, p. 207.

¹⁶ NATIONAL SCIENCE FOUNDATION, 2001. Societal implications of nanoscience and nanotechnology: výskumná správa. Maryland : WTEC, p. 370.

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Omówienie

Nanotechnologie są obecnie bardzo szybko rozwijającym się kierunkiem. Z wieloma ich zastosowaniami można się spotkać w powszechnej praktyce, nieustannie powstają nowe innowacje, pracuje się nad patentami, które miałyby ułatwić życie w przyszłości. Chęć przyjrzenia się nanotechnologiom z punktu etyki odsłania trudności w ocenie możliwości, jakie te technologie przynoszą. Należy zwrócić uwagę na prawdziwie etycznych problemach oraz potencjalnych niebezpieczeństwach, aby tym samym pozbawić się nierealnych wizji. Naszym celem jest zaproponowanie spojrzenia na etyczne pytania, które należy stawiać już dziś, a także w bliskiej przyszłości. Praca koncentruje się na wytypowaniu głównych etycznych problemów nanotechnologii. Celem jest zasugerowanie możliwego etycznego ryzyka, usystematyzowanego według poszczególnych dziedzin. Dotyczy to, na przykład środowiska, zdrowia, technologii informacyjnych itp. Efektem jest przeglądowy schemat pytań, które miałyby być kolejno rozwiązywane z punktu widzenia stosowanej etyki.