

Globalization, Medical Technologies, And Bioethics: Challenges And Opportunities In The 21st Century

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Abstract: The globalization of healthcare has profoundly transformed medical technologies, education, and international cooperation. Enhanced information exchange and digital communication have accelerated the transfer of medical innovations, such as robotic surgery and AI-based diagnostics, across borders. At the same time, globalization has facilitated the rise of new fields such as roboethics, addressing the ethical implications of robotics and artificial intelligence in medicine. Furthermore, the adoption of international standards, such as ISO guidelines, along with the implementation of the UN Sustainable Development Goals, has contributed to the harmonization of healthcare policies and the promotion of global health equity. However, these developments also raise pressing bioethical concerns, including genetic research dilemmas, data protection, equal access to advanced technologies, and the balance between local needs and international investments. This paper argues that to ensure the sustainable and humane progress of medicine, globalization must be aligned with universal ethical norms, social justice, and the protection of human dignity.

Keywords: Globalization. Medical Technologies, Bioethic, Roboethics, Artificial Intelligence, Genetic Research, Telemedicine, Healthcare Standards, Sustainable Development Goals, International Cooperation.

Introduction: The proliferation of information in the globalized age has enabled researchers and clinicians around the world to remain continually updated on cutting-edge research and technological innovations. Enhanced information flows and digital communication channels have shortened the time needed to disseminate new findings, facilitating faster uptake of evidence-based practices and improvements in clinical care. As a result, the international medical community benefits from more rapid knowledge transfer and collaborative problem-solving.

One tangible outcome of this process is the cross-border transfer of medical technologies. Innovations created in one country ranging from advanced medical devices to innovative diagnostic and therapeutic modalities are increasingly adapted to local contexts and integrated into health systems elsewhere. A notable example is robotic surgery: originally developed in the United States, robotic platforms have been adopted by hospitals around the world,

illustrating how technological breakthroughs can achieve global clinical impact when paired with information exchange, regulatory harmonization, and professional training.

As a result of the invention and widespread use of robots, the term roboethics was introduced in 2002 by Italian professor Gianmarco Veruggio. In 2004, the First International Symposium on Roboethics was held in Sanremo, where engineers, scientists, philosophers, sociologists, anthropologists, and writers from different countries participated. At this symposium, the term roboethics was officially proposed. Roboethics is considered a branch of applied ethics aimed at developing scientific, cultural, and technical solutions that can be shared by different social groups and people of various beliefs. It studies the ethical, social, and legal aspects of the interactions between humans and robots. Scholars working in the field of roboethics call themselves cyber-philosophers. [1] "In medicine, roboethics plays an important role in developing standards that ensure the ethical and moral use of

robotics. In 2006, Veruggio developed a roadmap for roboethics based on respecting values related to dignity and human rights, promoting equality and justice in the use of new technologies, protecting cultural diversity and pluralism, and preventing discrimination and stigmatization". [2]

It should be noted that the fundamental principles of bioethics undergo certain transformations in the field of roboethics. For example, the principle of justice in bioethics, which implies the fair distribution of medical care and resources regardless of social status, position, or other factors, takes on a more complex meaning in roboethics. Here, justice is not limited to the equal distribution of resources, but also includes consideration of the consequences of decisions made by artificial intelligence and robotic systems.

In roboethics, this principle is directed towards eliminating discrimination, ensuring common benefit and well-being, and creating equal opportunities for access to medical technologies. Its proper implementation is especially important in addressing problems related to inaccurate databases within social insurance and healthcare systems.

Moreover, just as in bioethics, roboethics also considers social differences arising from people's personal and individual characteristics (gender, age, ethnic origin, etc.). «However, since in this context decisions are automated through robotic systems or artificial intelligence algorithms, the realization of the principle of justice requires a broader ethical and legal approach». [3]

As a result of globalization, the process of developing, adopting, unifying, and disseminating international standards and regulations in the field of medical technologies is accelerating. Naturally, this process creates convenience and safety for the use of medical technologies in different countries.

It is known that in 2015, the United Nations (UN) General Assembly adopted 17 Sustainable Development Goals (SDGs) to be achieved by 2030. This global program covers a wide range of issues related to improving living standards, strengthening health, protecting natural resources, and enhancing the state of the environment. Moreover, 13 of the adopted goals are directly aligned with the areas of activity of the World Health Organization (WHO). These goals are aimed at ensuring public health on a global scale, preventing diseases, developing healthcare systems, and strengthening international cooperation.

It should be particularly emphasized that the goal supported by all UN member states «Ensuring healthy lives and promoting well-being for all at all ages' is considered one of the most important directions of the

global sustainable development agenda. This goal envisions improving human health and quality of life, providing medical services equally and fairly for everyone, and fostering the formation of a healthy society». [4]

It should be especially noted that in order to gradually implement the UN Sustainable Development Goals by 2030, the Cabinet of Ministers of the Republic of Uzbekistan adopted the National Sustainable Development Goals until 2030. This document includes 16 national goals and 125 related tasks. Among them, the third national goal, 'Ensuring healthy lifestyles and promoting well-being for all at all ages,' has been identified as one of the priority directions of the country's healthcare policy. It consists of 13 tasks and 23 indicators, and in recent years, significant positive results have been achieved. These results demonstrate the effectiveness of healthcare system reforms in the country and the implementation of comprehensive measures aimed at improving public health.

Furthermore, the UN's Goal 3 is being implemented in close connection with the «Uzbekistan – 2030» Strategy. In particular, the following target indicators have been set: «reducing by half the mortality rates among women, infants, and children under five, increasing the number of maternity beds by 35%, reducing infectious and non-infectious diseases among children by 20%, and ensuring full coverage of 120,000 oncology patients with modern treatment methods". [5]

Achieving high results, first of all, requires creating broad access to safe, effective, and high-quality medical services and medicines. Therefore, the World Health Organization (WHO) has paid special attention to this issue and adopted Resolution WHA55.R18 at the 55th World Health Assembly. According to this resolution, healthcare institutions must create a safe environment for patients, develop guidelines based on global norms and standards, strengthen the assessment of medical care quality, and enhance the monitoring of medicines and medical equipment.

In many cases, having an international quality certificate is considered a key requirement for a medical institution to participate in state and international tenders. In this regard, the first standard rules were proposed by ISO (International Organization for Standardization), and today its standards for medical services are continuously being updated. [6]

It should be emphasized that international ISO standards have the highest level of compatibility and often serve as a basis for developing local standards (such as GOST and others). These standards are developed by the relevant technical committees of the

International Organization for Standardization (ISO). Specialists and experts from different countries are involved in these committees, and their scientific and practical experience plays an important role in defining global norms. In this way, «a number of international standards aimed at ensuring social responsibility and quality have been adopted, which are also applied at the local level, contributing to the improvement of healthcare and the efficiency of medical services». [7]

Globalization has created opportunities for medical technology manufacturers to enter international markets. As a result, pharmaceutical and medical equipment companies have been able to rapidly distribute their products worldwide. During the COVID-19 pandemic, the market grew by more than 10% annually due to high demand and investments, however, after the epidemiological situation stabilized, a decline was observed. Currently, the market is returning to a stable growth trajectory. In particular, «innovative segments such as AI-based diagnostics, medical robotics, and digital technologies are developing rapidly with growth rates reaching up to 26% per year. The global medical technology market is currently estimated at approximately 503 billion USD, with an annual growth rate projected at around 4%». [8]

At the same time, with the rapid development of medical technologies, the scope of bioethical issues is also expanding. In particular, genetic research raises a number of unresolved questions for human life and society. Can a human being become a 'co-author' of biological evolution? Could biogenetic inequality turn into a new form of social inequality? To what extent should the state and society regulate genetic research? Should genetic testing be open to everyone and even made mandatory? To what extent is it acceptable to use their results in decisions regarding abortion, insurance, or employment? How can the right to know one's genetic future and the guarantee of confidentiality be ensured? «These and similar questions are posing new bioethical dilemmas before humanity». [9] The question of when and how solutions to these issues will be found, and most importantly, to what extent they will align with human dignity and universal ethical standards, remains unresolved.

Global educational programs and international practices provide medical specialists with opportunities to learn and master modern technologies, making their integration into local healthcare systems easier. The development of technology and communications has expanded opportunities for distance learning, opening access to science and education for more people. Based on global communication and cooperation, the experiences of different countries are being integrated,

enriching medical knowledge on a global scale. As a result, globalization processes have had a profound impact on the field of medical education, leading to the massification of higher medical education and the formation of the global education market. Global educational programs serve to train highly qualified medical professionals, but from a bioethical perspective they also raise issues such as equality, cultural diversity, information security, and social justice.

Globalization strengthens international cooperation between hospitals, research institutes, and medical institutions, enhancing the exchange of knowledge and technologies. For example, international conferences and symposia create opportunities to widely disseminate the latest achievements in medicine. International cooperation is an important factor in developing modern medical education and science. In turn, it includes exchange programs and internships for specialists, students, and graduate students, short- and long-term joint projects, prevention of socially significant diseases, drug monitoring, and promotion of healthy lifestyles, cross-cultural research in cardiology, pediatrics, psychology, and other areas, preparation of scientific-methodological materials to enhance the capacity of faculty and researchers, as well as organizing joint seminars and trainings. International projects serve not only for experience sharing, but also for improving the qualifications of specialists at universities and medical institutions. However, international cooperation in biomedicine requires consideration of bioethical principles such as equality, cultural diversity, human rights, confidentiality, and the balance of interests.

Modern information technologies are creating wide opportunities for the development of medical knowledge and practice. Medical information systems collect comprehensive data about patients, speeding up early detection and diagnosis of diseases. Integrated sensor devices, smart watches, wristbands, and similar tools make it possible to continuously monitor vital signs and detect potential problems in advance. Telemedicine technologies provide broader access to healthcare services, which is especially important for populations living in remote areas. Artificial intelligence algorithms are introducing a new stage in medical diagnostics, expanding the possibilities of analyzing images, detecting pathologies, and predicting risks. Moreover, big data analysis facilitates epidemic forecasting, personalized treatment, and consideration of genetic factors. Transitioning to electronic healthcare systems simplifies data exchange, reduces the risk of medical errors, and enables rapid access to critical information in emergencies. At the same time,

while information technologies make diagnostics, treatment, and healthcare delivery more effective and precise, they also require strict adherence to bioethical standards.

On the other hand, working with big data requires the protection of personal information, and the use of telemedicine and digital services is not equally accessible to all, especially in economically and technologically disadvantaged regions, which increases inequality. At the same time, in the process of using data collected through artificial intelligence or sensor devices, it is necessary to ensure patient awareness and informed consent.

International investments and grants help finance research and development in the field of medicine. By funding medical research and development, international investments and grants support the introduction of new technologies in different countries. In 2024, Uzbekistan planned to purchase medical equipment worth 150 million USD, with the main part financed through foreign concessional loans and direct investments, as well as grants from international organizations such as KOICA, JICA, and USAID. As a result, «the country's emergency medical care system was equipped with modern devices, family hospitals and specialized centers were upgraded, and the scope of high-tech surgical operations and oncology services was expanded». [10]

From a bioethical perspective, international financing not only enhances the quality and efficiency of medical services but also raises a number of crucial issues. Among them, fair distribution, equal access to resources, protection of public health, and consideration of local needs become key priorities. At the same time, advanced technologies introduced through international grants and investments must be accessible to all social groups, while ensuring their confidentiality and safety.

The process of globalization is also expanding opportunities for the free mobility of highly qualified medical specialists and for the exchange of experience and knowledge between different countries. This fosters the rapid development of medical technologies and biomedical research, contributes to the improvement of healthcare quality, and supports the overall progress of health systems.

However, this process also highlights the need to harmonize ethical standards and regulate technologies. In particular, within the scope of new treatments and genetic research, such key ethical issues as ensuring patient safety, creating opportunities for equal access to modern therapies, and protecting personal data become increasingly urgent.

CONCLUSION

In conclusion, to effectively benefit from the opportunities of globalization, it is essential to act in harmony with its bioethical constraints and standards. Only in this way can the advancement of medicine become truly humane, sustainable, and just.

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