Committee: United Nations Commission Science and Technology Development

Issue: Promoting artificial organ implant and maintenance in LEDCs

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Introduction

Artificial organs have revolutionised the medical field, offering replacement or assistance to natural organs and significantly improving the quality of life for patients suffering from organ failure. However, there are international issues surrounding the development and transplantation of artificial organs that need to be addressed. These issues include the high cost, unequal distribution, and shortage of organ donors, which significantly impact global healthcare systems.

The cost of artificial organs poses a significant challenge in many countries globally. For example, the average cost of a heart transplant in the United States ranges from $1.2 million to $1.5 million, while a kidney transplant can cost up to $200,000 [1]. A heart transplant costs approximately $70,000 in India, and a kidney transplant ranges from $12,000 to $15,000[2]. These high costs make it difficult for individuals in low-income countries to access the necessary artificial organs.

Furthermore, the shortage of organ donors is a pressing issue worldwide. According to the World Health Organization (WHO), around 170,000 kidney transplants, 34,000 liver transplants, and 27,000 heart transplants are performed annually, yet the demand far exceeds the supply [3]. In some countries, such as China and India, there are long waiting lists for organ transplantation, with thousands of patients waiting for suitable donors. The scarcity of organs leads to high mortality rates among patients awaiting transplantation.

Addressing the challenges of artificial organ development and transplantation requires collaborative international efforts. The UN Sustainable Development Goals (SDGs) call for affordable and equitable healthcare for all, aiming to improve the well-being of populations worldwide. Less economically developed countries (LEDCs) face additional challenges accessing artificial organs due to limited resources, infrastructure, and funding. The cost of research, development, and implementation of artificial organs is often beyond the capabilities of these countries. These disparities in access to artificial organs can contribute to healthcare inequities on a global scale.

Definition of Key Terms

Artificial Organ

An artificial organ refers to a human-made device or replacement organ designed to mimic or perform the functions of a natural organ in the human body. It is created to replace the role of a damaged or diseased organ or to enhance the existing process of a healthy organ. For individuals with organ failure or dysfunction, artificial organs are typically developed using various technologies, such as engineering, biomaterials, and regenerative medicine.

Biocompatibility

Biocompatibility refers to the ability of an artificial organ or device to function within the body without causing harmful effects or rejection, assuring that the product, such as the artificial organ, poses minimal toxicity, injury potential, or physiological/immunological reactivity.

Immunosuppressive agents

Immunosuppressant is a class of medicines that inhibit or decrease the intensity of the immune response in the body. These medications are used to make the body less likely to resist a transplanted organ or tissue. When the human body detects an antigen, any foreign substance that induces an immune response, the immune system recognises the antigen and gets rid of it. Proteins called antibodies bind to unwanted substances (antigens) to eliminate them.

Since artificial/donors' organs are also foreign substances, our body recognises them as antigens and often attacks them by immune response. Therefore, in order to suppress such an immune response that destroys artificial organs, patients who have done organ transplantation must take immunosuppressive agents for their lifetime.

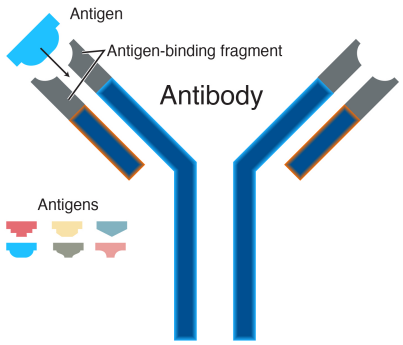


Fig 1. Antigen and antibody

Organ trafficking

Organ trafficking refers to the illegal trade and trafficking of organs, where organs are procured from individuals without their consent, often exploiting vulnerable populations. Discussions would revolve around preventing and addressing this unethical practice.

3D Bioprinting

3D Bioprinting refers to a technology where bioinks, mixed with living cells, are printed in 3D to construct natural tissue-like three-dimensional structures.

History

The first successful kidney transplant took place in 1954. The recipient received a kidney from his identical twin brother, demonstrating the feasibility of organ transplantation and sparking further research in the field. Fifteen years later, in 1969, another pivotal moment occurred with the implantation of an artificial heart. Though the recipient tragically passed away after 64 hours with the artificial heart, this pioneering procedure laid the foundation for developing more advanced artificial heart technologies.

The year 1977 established the International Society for Artificial Organs (IFAO), fostering collaboration among researchers, clinicians, and policymakers worldwide. Through annual meetings, publications, and research initiatives, the IFAO has advanced artificial organ technologies and disseminated knowledge in the field.

In 1982, the first permanent artificial heart, known as the Jarvik-7, was successfully transplanted. This achievement, succeeding in keeping the patient alive for 112 days, represented a remarkable leap forward in the field of artificial heart implants, providing valuable insights into the challenges of long-term use.

Several events in 1984 have brought public attention to the issue of organ transplantation. The case of Baby Fae in 1984, who received a baboon heart transplant but died a few weeks later, raised ethical questions about organ transplantation in children. Similarly, the Hela cells, which were taken without the knowledge or consent of the patient and have since been widely used in medical research, highlighted issues around informed consent and patient rights. These events have shed light on critical ethical issues related to organ transplantation and emphasised that it is crucial to raise public awareness and education about the importance of informed consent, patient rights, and ethical practices in organ donation and transplantation through community outreach programs, public service announcements, and education in medical schools.

In 2008, the United Nations made a resolution by adopting the "Universal Declaration on Bioethics and Human Rights." This document emphasised the importance of conducting scientific and

technological advancements, including those in the field of artificial organs, with utmost respect for human rights and dignity. The declaration called for international cooperation in promoting bioethical principles, safeguarding individual autonomy, and respecting cultural diversity concerning the use of artificial organs and related technologies.

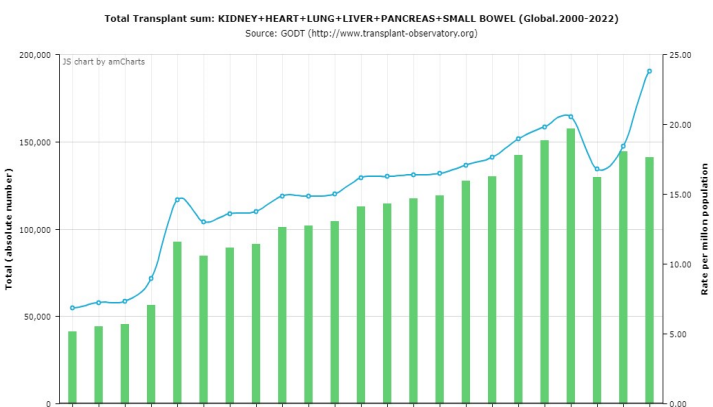
Rapid progress in tissue engineering and regenerative medicine has led to the development of bioengineered organs in recent years. A notable achievement in 2011 involved the transplantation of the first synthetic windpipe into a patient in Sweden. This groundbreaking procedure involved seeding a synthetic scaffold with the patient's stem cells, eliminating the need for immunosuppressive drugs and demonstrating the immense potential of personalised artificial organs.

Today, 3D bioprinting technology stands at the forefront of artificial organ research, holding immense promise for the future. Researchers have successfully printed functional tissues using patient-specific cells and biocompatible materials, such as cardiac patches, liver tissues, and kidney models. This revolutionary approach offers hope in addressing the organ donor shortage and reducing the risk of rejection, paving the way for transformative changes in healthcare.

Key Issues

Affordability and Accessibility

The cost of artificial organs, including their procurement, implantation, and long-term maintenance, can be prohibitive for individuals and healthcare systems in LEDCs. Limited financial resources and inadequate health insurance coverage often restrict access to artificial organs, making them accessible only to a privileged few. According to data from the Global Database on Donation and Transplantation (GODT), the overall transplantation rate increased from 2000 to 2022. Still, the number of transplantations in LEDC countries was not available. For countries with data, although very few, the transplantation rate was at a low rate compared to developed countries. Among 46 LEDCs, total organ transplant data was unavailable in 43 countries. Measured in rate per million population (pmp), Afghanistan reached 132 pmp, Bangladesh 269 pmp, and Ethiopia 9 pmp, which are way too low compared to the United States (43,743 pmp) and Spain (5,385).



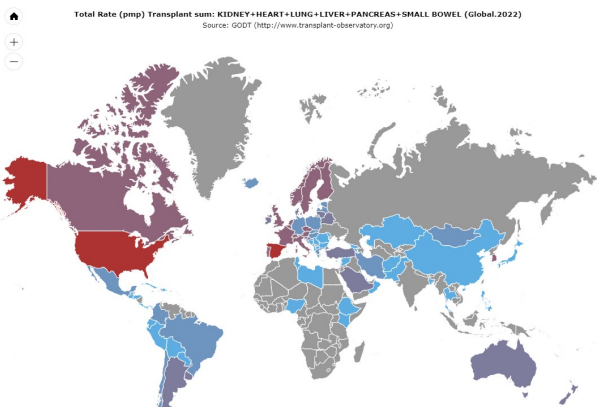


Fig 2. Total transplant sum (global, 2000-2022) **Fig 3. Real rate (pmp) transplant sum (2022)**

Maintenance and Follow-up Care

Some pitfalls and challenges artificial organs face are product failure after transplantation and the rising prevalence of infections due to the material used for artificial organ development. Successes have been achieved: one study saw 80% of patients with artificial hearts surviving for over a year and some for six years. The longest time a patient was supported to transplant was 1,373 days. [9] However, severe infectious complications were still common. Therefore, Artificial organs require regular monitoring, adjustment, and maintenance to ensure proper functioning and longevity. This may involve specialised diagnostic equipment, follow-up appointments, and access to technical support. LEDCs may face challenges in providing these essential post-operative services, leading to difficulties in maintaining artificial organs effectively.

Training and Education on Ethical Consideration and Specialized Knowledge

Ethical problems such as patient selection arise as artificial organs sustain human life. According to the Health Resources and Services Administration (HRSA), 104,234 people in the US are on the national transplant waiting list, and 17 people die daily waiting for an organ transplant. Ideal candidates have died in the US for lack of transplants and chronic dialysis treatment. Since donor and artificial organs are limited resources, rigid selection must consider ethical issues. Also, other ethical problems, such as informed consent, should be deemed. Currently, the training and education of healthcare professionals are insufficient to handle the complexities of artificial organ implantation and subsequent patient care. Specialised knowledge, technical expertise, and ongoing training programs are required to ensure effective implantation, management, and maintenance.

Major Parties Involved and Their Views

Non-profit Organizations

Declaration of Istanbul Custodian Group (DICG)

Declaration of Istanbul Custodian Group (DICG) promotes, implements and upholds the Declaration of Istanbul to combat organ trafficking, transplant tourism and transplant commercialism and to encourage adoption of practical and ethical transplantation practices around the world. In 2008, the organisation presented the Declaration of Istanbul on Organ Trafficking and Transplant Tourism. The declaration asserts that because it targets impoverished and otherwise

vulnerable donors, the commercialism of transplantation leads inexorably to inequity and injustice and should also be prohibited.

International Federation for Artificial Organs (IFAO)

The International Federation for Artificial Organs aims to increase and encourage knowledge and research on artificial organs, apheresis, tissue engineering, and regenerative medicine to facilitate the international exchange of knowledge, and to provide education related to the improvement and optimal utilisation of organ assist devices. The annual conference has been held since 1977 in different countries.

United Nations Departments

World Health Organization (WHO)

The WHO plays a central role in global health and has a specific focus on organ transplantation, including the ethical and safe use of artificial organs.

United Nations Development Programme (UNDP)

The UNDP works on promoting sustainable development, including improving healthcare systems and infrastructure, which can indirectly support the implementation of artificial organ programs.

United Nations Industrial Development Organization (UNIDO)

UNIDO provides technical assistance and capacity-building support for developing countries, which could be relevant for enhancing manufacturing capabilities for artificial organs.

Countries

United States

The United States has made significant contributions to the field of artificial organs, including research, development, and clinical implementation. Organisations like the National Institutes of Health (NIH) and the Food and Drug Administration (FDA) play important roles in regulation and oversight. The US recently planned for a more fluid and efficient way for organ transplants and revealed that the plan would nearly double the amount of funding the government agency (HRSA) receives from the US to $67 million in the fiscal year to 2024 to modernise the nation’s transplant system.

Germany

Germany is recognised for its medical expertise in technology, and it has achieved advances in artificial organs. The German Society for Biomedical Engineering (DGBMT) and the Leibniz Research Laboratories for Biotechnology and Artificial Organs (LEBAO) are both carrying out related research and development.

Japan

Japan has been at the forefront of innovation in healthcare technologies, including artificial organs. Organisations such as the Japan Organ Transplant Network and the Japan Tissue Engineering Society contribute to research, education, and policy development in this area.

Less Economically Developed Countries (LEDCs)

LEDCs have faced issues with organ trafficking and lack adequate health infrastructure or technology for artificial organs.

Timeline of Relevant Resolutions, Treaties and Events

Date	Description of event
1945	Willem Kolff creates the first successful artificial kidney, the hemodialyser,
1982	The Jarvik-7, an implantable artificial heart designed by Dr. Robert Jarvik, receives FDA approval and becomes the first artificial heart to be successfully implanted in a human. It is a machine heart designed for temporary use and gives a life expectancy of about ten months.
1999	The research team of Anthony Atala grew artificial bladders made up of human cells for seven children who were born with spina bifida and several malfunctioning bladders. Patients were tracked for several years to ensure the organs were functioning properly, and the research paper was released in 2006
2005	World Health Assembly Resolution WHA58.13 addresses organ trafficking and transplantation tourism, indirectly influencing ethical practices and oversight in the development and use of both natural and artificial organs.
2006	By using a virus to inject 24 carefully selected genes into skin cells extracted from mice, Shinya Yamanaka was able to reprogram them into embryonic stem cells. (Induced Pluripotent Stem Cells)

2008	Declaration of Istanbul on Organ Trafficking and Transplant Tourism provides ethical guidelines to combat organ trafficking and transplant tourism, promoting transparency, fairness, and protection of the vulnerable, including in the development and utilization of artificial organs.
2008	The first artificial organ grown in a lab using stem cells was transplanted by Dr. Paulo Maccharini.
2014	United Nations Sustainable Development Goals (SDGs) address good health and well-being/ industry, innovation, and infrastructure/ reduced inequalities/ partnerships for the goals
2019	The World Health Organization (WHO) Guiding Principles on Human Cell, Tissue, and Organ Transplantation provide a framework for promoting ethical practices in organ transplantation, including the use of artificial organs, with a focus on informed consent, equitable access, traceability, and transparency in donation and transplantation processes.
2020	Scientists successfully 3D print a functional human heart using a patient's own cells, showcasing the potential of organ bioprinting technology.

Evaluation of Previous Attempts to Resolve the Issue

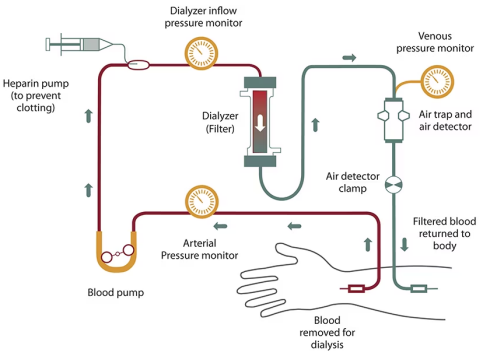
One policy that was implemented was the establishment of the World Health Organization (WHO) Global Task Force on Donation and Transplantation of Human Organs and Tissues. This task force aimed to promote organ donation and transplantation and to develop policies and guidelines to address the global shortage of organs. However, despite these efforts, the demand for organs continues to exceed the supply, and many patients in LEDCs remain unable to access life-saving organ transplants. The task failed to address the root causes of the organ shortage and should expand its focus to include improving access to healthcare services and increasing public awareness and education about organ donation.

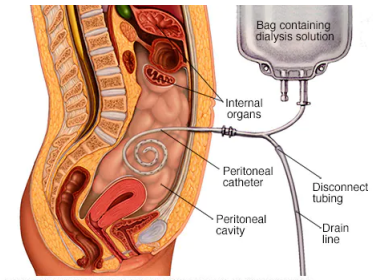
Another initiative that was launched in 2008 was the Declaration of Istanbul on Organ Trafficking and Transplant Tourism. This policy aimed to combat organ trafficking and transplant tourism, which were major issues in some LEDCs. However, there are still reports of organ trafficking and illegal transplants occurring in some parts of the world. It needs to be better implemented and enforced: governments should strengthen their legislative frameworks and increase collaboration with international organisations and law enforcement agencies to prevent illegal organ trafficking and transplantation.

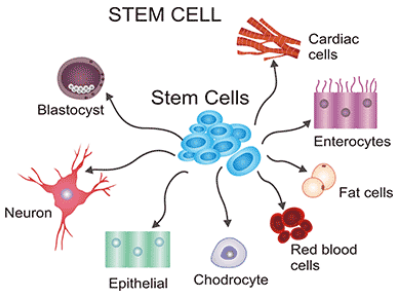
The development of artificial kidneys through hemodialysis[1] and peritoneal dialysis[2] has helped to improve the survival rates for patients with end-stage renal disease. However, these treatments require ongoing medical equipment and access to specialised healthcare services, which can be challenging for patients in LEDCs who live in remote areas or have limited financial resources. To make this attempt better, efforts should be made to expand access to these treatments by increasing funding for medical technologies, improving transportation networks, and increasing the number of trained healthcare providers who can deliver these treatments.

Another attempt to develop artificial organs was the use of mechanical devices, such as artificial hearts, to support patients while they wait for a transplant. Although these devices have been effective in extending the lives of patients with end-stage heart disease, they come with significant risks related to infection, bleeding, and blood clots. Additionally, the high cost of these devices makes them largely inaccessible to patients in LEDCs. To make this attempt better, efforts should be made to reduce the cost of these devices, increase research funding for developing new technologies, and improve regulation of these devices to ensure safety and efficacy.

Stem cell[3] research has also been explored as a potential solution to the organ shortage problem. With the ability to differentiate into different cell types, stem cells have the potential to regenerate damaged organs and tissues. However, the use of stem cells remains controversial, and their efficacy is still uncertain. Additionally, the high cost of stem cell treatments makes them difficult to access for patients in LEDCs. To make this attempt better, efforts should be made to fund more research in this area, increase transparency around stem cell treatments, and improve education and public awareness about this emerging field of medicine.







[1] **Hemodialysis** is a method to treat advanced kidney failure and the process is done as a machine filters wastes, salts and fluid from patients' blood when their kidneys are no longer able to function adequately. It helps control blood pressure and balance important minerals, such as potassium, sodium, and celsius, in the blood.

[2] **Peritoneal dialysis** is a treatment for kidney failure that uses the lining of patients' abdomen to filter their blood. During the process, a cleansing fluid called dialysate passes through a catheter tube into part of the abdomen known as the peritoneal cavity. The dialysate absorbs waste products from blood vessels in the lining of the abdomen, called the peritoneum. Then the fluid is drawn back out of the body and discarded.

[3] **Stem cell** is a cell with the unique ability to develop into specialized cell types in the body.

Fig 4. Hemodialysis **Fig 5. Peritoneal dialysis** **Fig 6. Stem cells**

Possible Solutions

Growth drivers such as global scarcity of organ donors, increasing incidence of organ failures, and growing technological advancements brought the growth in the artificial organs market. Even so, globally, 1.2 million people die each year from kidney failure. [17] Solutions to the issue of promoting artificial organ implants and maintenance in LEDCs must focus on reducing healthcare inequalities both among countries and within each country. To these ends, increased international funding and resource allocation to LEDCs are essential. According to the World Health Organization (WHO), access to healthcare remains unequal globally, with a significant disparity in resources between high-income and low-income countries. In many LEDCs, healthcare infrastructure and technology are underdeveloped, leading to limited access to medical advancements such as artificial organ implants. Also, in most LEDCs, information on organ transplantation rates are not adequately captured or accurately recorded, making it challenging to assess and identify areas that need improvement. By fostering collaboration between healthcare organisations and governments, scrutinising the number of organ transplants in the countries is vital.

Collaborative partnerships between developed and developing countries promote knowledge, technology, and resource transfer. There have been successful collaborative efforts between developed and developing countries to promote health technologies through initiatives such as the Global Health Innovative Technology (GHIT) Fund. The fund facilitates partnerships to accelerate the discovery and development of new health technologies for infectious diseases, showcasing the benefits of shared knowledge and resources.

Educational opportunities and infrastructure development in LEDCs are also critical as they foster local talent and contribute to the advancement of healthcare technologies in these regions, promoting greater equitable access to artificial organs. For instance, the establishment of medical research centres and educational institutions in LEDCs can foster the growth of a skilled workforce capable of contributing to the development and maintenance of artificial organs.

Global efforts are required to achieve universal access to artificial organs and improved healthcare systems. LEDCs can become better equipped to embrace healthcare innovations, including artificial organ implants. They can also improve healthcare systems when disparities are reduced, and local capacity is developed.

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