

Nanomedicine, Poverty and Development

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ABSTRACT *The application of nanotechnologies in the field of health is profiled as one of the most promising. Nanomedicine is even seen as a fundamental element in the fight against poverty. Nevertheless, Noela Invernizzi and Guillermo Foladori argue that intrinsic characteristics of nanomedicine could widen still further the gap between haves and have-nots.*

KEYWORDS *nanodivide; MDGs; technology; magic bullet; social injustice*

Introduction

It is quite possible that in the coming decades, significant changes in human life and society will take place as a result of nanotechnologies. Some of the most promising applications lie in the field of nanomedicine. Scientists are talking about faster and more accurate ways of diagnosing disease, new ways of targeting drugs directly to the diseased cells or organs and the regeneration of organs, bones or teeth, using a patient's own tissues. On the whole, these technologies promise to lengthen the human lifespan and reverse the effects of ageing.

We analyse these technological hopes in the worldwide socio-economic context. It is reasonable to wonder whether the existence of more efficient and cheaper technologies will mean that their effects will benefit those who really need them. Is it true that nanotechnology offers hope for the poor and developing countries? We show that there are technical and social barriers that hinder nanomedicines reaching the poor.

Nanotechnologies, development and poverty

The development and diffusion of nanotechnologies will have far reaching effects on the economy and society on a global scale. In developing countries, with their economic and social problems and their huge poor populations, the effects of nanotechnologies will undoubtedly be complex and disruptive (Meridian Institute, 2005, www.nanoandthepoor.org, accessed 13 September 2005; ETC Group, 2005, <http://www.southcentre.org/publications/researchpapers/ResearchPapers4.pdf>, accessed 9 June 2006; Invernizzi and Foladori, 2005).

There are scholars and institutions that see nanotechnologies as having enormous potential for solving the problems of poverty and stimulating development. We argue that this optimism is founded in two arguments. It considers that nanotechnologies

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outcomes could mechanically benefit the poor; and it assumes that increased competitiveness will automatically lead to development.

The first batch of optimistic ideas we call nanotechnologies for the poor. Governments, scientists and international organizations have emphasized in several reports that nanotechnologies have the capacity to improve the living conditions of the poor. An example of this is the view of the *Task Force on Science, Technology and Innovation* of the UN Millennium Development Project (Juma and Yee-Cheong, 2005, <http://www.unmillenniumproject.org/documents/Science-complete.pdf>, accessed 13 September 2005). The Canadian Joint Center for Bioethics also holds the belief that nanotechnology can be used to help achieve five of the eight Millennium Development Goals (Salamanca-Buentello *et al.*, 2005, <http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0020097>, accessed 20 May 2005). In fact, as these reports highlight, two of the most serious problems in the developing world are the lack of drinking water and the scarcity of energy. Several relatively cheap nanotechnologies have already been developed to filter bacteria, viruses and other harmful pathogenic elements from water to make it fit for drinking. In the field of energy, with the help of nanotechnologies, it is possible to produce cheap photovoltaic films that can be laid across the roofs of buildings, or even solar film paint. There have also been important advances in carbon nanotubes for storing hydrogen and nanomaterials that make aero-generators lighter and more efficient.

The optimistic viewpoint emphasizes that nanotechnologies are technically superior to existing technologies when it comes to solving specific problems. Problems such as energy, drinking water or disease diagnosis, that have lot to do with social and economic issues, are set as just technical questions that have technical solutions. No social context analysis is made, nor are conventional technology transfer issues evaluated, revealing a mechanical vision of the relationship between technology and society. Under this perspective, to benefit the poor with nanotechnologies seems to be merely a matter of political will and ethics.

The second group of ideas stems from nanotechnology for competitiveness policies. The main aim of these policies is to climb to competitive levels in the world market. It is considered that, at least in some fields, developing countries can successfully fill the niches of the promising global market for nanoproducts. This point of view is reflected in the rapid and growing trend in research in nanosciences and nanotechnologies in developing countries. There are two central arguments that serve as premises for these policies. The first is that nanotechnologies, by implying a paradigm shift, would allow a catching up process for developing countries. In a document issued by the Brazilian Ministry of Science & Technology, for instance, it is argued that 'in an upcoming paradigm shift imposed by nanoscience and nanotechnology, we are now faced with a unique opportunity to enter a new era at the same level as the developed countries' (MCT, 2003: 8, <http://www.mct.gov.br/Temas/Nano/prog.nanotec.pdf>, accessed 12 July 2005). The second argument is that no country in the future will be able to develop without nanotechnologies. This is clearly stated by the president of the Third World Academy of Sciences, Mohamed Hassan (2005: 66) '...developing countries have no choice but to embrace nanoscience and nanotechnology if they hope to build successful economies in the long term'.

Thus, in a context considered both favourable and inevitable, the emphasis of nanotechnology policies is placed on improving competitiveness through the stimulation of innovation which, it is argued, will be translated into greater development in both economic and social terms. Although these policies pay a great deal of attention to the transference of scientific development to the productive sector, they still consider that development and satisfaction of social needs emerge automatically from competitiveness improvement. The fact that some countries could successfully enter the market of nanoproducts does not imply by any means that their poor people will benefit, and therefore that internal inequality will be reduced. In fact, the intense technological development of the last three decades has been accompanied, at a global level, by an increase in poverty and inequality, as shown in the United

Nations Human Development Report (2005), <http://hdr.undp.org/>, accessed 13 September 2005.

Neither the nanotechnology for the poor nor the competitiveness approach is convincing enough to consider nanotechnologies as instruments for reducing poverty and to trigger development, for several reasons. They overlook that the market is a barrier for wide sectors of the impoverished population to access the potential benefits of nanotechnology. They do not analyse the socio-economic starting point of this technological revolution, which is an extreme concentration of wealth and a huge gap between haves and have-nots. They do not understand that the main impulse for innovation is not the satisfaction of social needs but the drive for profit. Finally, the technological trajectory (nanotechnology) is assumed as the only possible one, closing the doors on other technological and development alternatives, that could be more suitable for meeting the needs of the poor under their local conditions. In the following section, we analyse, using nanomedicine as example, how the socio-economic context can become a barrier that hinders the promises of nanotechnology to reach the poor.

The promise of nanomedicine

The application of nanotechnologies in the field of medicine is very promising. There are three main areas where current research and application is concentrated (Malsch, 2002, <http://www.aip.org/tip/INPHFA/vol-8/iss-3/p15.pdf>, accessed 15 March 2005). One of these is *diagnostics*. Diagnosis of many diseases is very expensive, takes hours or days and requires the patient or samples to travel to a laboratory. The key to new mechanisms for diagnosis using nanotechnologies lies in sensors on the nanoscale that can be placed within the human body. The lab-on-a-chip consists of devices on the nanoscale that pass through a patient's bloodstream like a virus. It is capable of selecting tiny particles of liquid and gas and analyses them. They are true laboratories, which allow for the analysis of large quantities of components at the same time. Efforts are also oriented to perform DNA analysis. Using quantum dots it is also

possible to search out diseased cells and mark them; thereby an illness could be detected in the first moments, 'anticipating' a disease even before the body itself shows any reaction.

Another promising area of nanomedicine is that of *drug delivery*. What is at stake is the possibility to target drugs directly onto the affected cells or organs. This is done using nanomaterial coatings to encapsulate drugs that will be dissolved at the targeted site. This mechanism has several advantages. One is that it avoids harmful effects on healthy cells and tissues that do not require the drug, as happens with nowadays drugs that flood the whole body. Another is that by going directly to its target, it is possible to increase the dosage. A more sophisticated version are drugs that act only when necessary, the so-called smart drugs. A drug molecule can release a certain antibiotic only when an infection is present.

The third promising field of research is that of *implants and prostheses*. This ranges from repairing bones and teeth to any type of tissue. Nanomaterial coatings could increase the durability and adhesion of implants. Biological nanostructures could improve tissue regeneration. Nanoscale devices could be implanted as sensors that monitor the environment, detect properties and deliver medicines. Nanostructured material can also be used in artificial sensory organs such as electronic eyes and nerves, although many of these projects are still in their earliest stages.

Nanotechnologies, taken by themselves, are very promising for health improvement. Unfortunately health is not independent from its social, economic and environmental context.

Nanomedicine for the poor

When considering nanomedicine from a social perspective, two main characteristics arise that could become a barrier to improve the health of the poor.

The first is its *individualized treatment* (Pilarski *et al.*, 2004). This is clear in new diagnosis, which requires the connection between patient and physician or laboratory. Drug delivery is to be applied side by side with an individualized surveillance system, and in many cases depends on

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pharmacogenetics. Pharmacogenetics performs the analysis of the genetic diagnosis of the patient to determine her predispositions to illnesses and also analyses which drugs would have a better effect on that patient, providing individual care for the patient. Individualized medical treatment may be an advance in technical terms, but it is doubtful whether it is an advance in social terms. From the mid nineteenth century up to after the end of World War II, government health policies were based on mass treatment with vaccines and antibiotics. Vaccines were, and still are, the instrument for combating epidemics. For vaccines to have the social reach that is expected of them, it is necessary to have mass vaccination programmes. For their part, pharmaceutical companies had expanded their sales of antibiotics. Part of the increase in life expectancy in many countries in recent decades might be due to this policy of medication for the masses.

Nevertheless, most poor people have not always had access to these benefits. Even when the technique for medical treatment allowed for the mass application of vaccines or antibiotics, the commercial form of distribution marginalized the poor from such benefits. According to the World Health Organization (WHO), by 2002, 80 per cent of the world drug market was concentrated in North America, Europe and Japan, a geographic area where only 19 per cent of the world population lives. But, 90 per cent of the burden of disease is located in poor countries, where patients do not have the purchasing capacity to buy medicine. It is estimated that 18 million people died in 2001 of communicable diseases, because of lack of money to buy medicine or because of lack of appropriate medicine for particular diseases (MSF-DND, 2001). In fact, the interest of pharmaceutical corporations is in diseases of the rich people. Following Forbes, the world's ten best selling drugs in 2005 were all for rich patients (high cholesterol, heartburn, high blood pressure, schizophrenia and depression) (Herper and Kang, 2006, <http://www.wired.com/news/technology/1.70508-0.html>, accessed 7 June 2006).

Nanomedicine will not change this commercial form of distribution of medicine and treatments; and distribution will continue to be concentrated

in rich countries and for the upper classes. But, by individualizing treatment for the consumer, nanomedicine will further widen the gap between haves and have-nots. Medicines or treatments that cannot be distributed *en masse* constitute an additional difficulty in getting treatment to those with lower purchasing capacity or who live in locations where there is less medical infrastructure.

The second characteristic of nanomedicine that could be a barrier to improve the health of the poor is its *reductionist and top down medical approach*. According to WHO, up to 80 per cent of the African population uses traditional medicine for health care. In China, traditional herbal preparations accounts for 30–50 per cent of the total medical consumption (WHO, 2003, www.who.int/mediacentre/factsheets/fs134/en/, accessed 7 June 2006). The consumption of complementary and alternative medicines has also grown significantly in developed countries over the past few decades (Fisher and Ward, 1994). But research into nanomedicine is not aimed at developing traditional, alternative or complementary medicines that are the basis of the health systems of possibly most of the world's population. For these people, nanomedicine will be a top-down project that is out of their reach and world view.

Conclusion

Whereas traditional, complementary and alternative medicines are based on a holistic concept of treatment, the technological trajectory of nanomedicine leans towards a focus that is more similar to what is known as the 'magic bullet approach', in which one type of medication is applied for each illness. But in situations of poverty and precarious sanitary conditions and infrastructure of services, the eradication of a certain illness is rapidly supplanted by another. It is for this reason that holistic approaches may produce more appropriate results in these contexts.

Finally, sophisticated nanomedicine, which requires technological advances and specialized equipment, creates a knowledge barrier that is hard to overcome in poor regions and poor countries. Whereas traditional medicine holds the

possibility of expanding knowledge among users, nanomedicine tends to reserve its knowledge exclusively for the elite, even among doctors, nurses and laboratories themselves, widening the knowledge gap between patients and health professionals.

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