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NANOTECHNOLOGY- A PUBLIC HEALTH PERSPECTIVE

Dental Science

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ABSTRACT

Nanotechnology is an extremely diverse and multi-disciplinary field, ranging from novel extensions of conventional physics to completely new approaches based upon molecular self-assembly, to developing new materials and machines with nanoscale dimensions. Nanotechnology deals with structures in the range of 1–100 nm and focuses on the development of materials with novel properties often not present in nature. As a result, it is considered as a key technology of the twenty-first century and promised to deliver innovative methods to medicine and dentistry. It is expected that nanotechnology will have a major impact on medicine and health care; energy production and conservation; environmental clean-up and protection; electronics, computers, and sensors; and world security and defense. This review focuses on the impact of nanotechnology on the major public health problems and the issues concerned with use of nanotechnology in the health sector.

KEYWORDS:

Nanotechnology, public health, public health problem

INTRODUCTION

Science is undergoing yet another change, in helping mankind enter a new era, the era of Nanotechnology. Nanotechnology has emerged as cutting edge advancement combining biomedical science and technology. Recent years have witnessed an unprecedented growth in research in the area of nanoscience. There is increasing optimism that nanotechnology applied to medicine and dentistry will bring significant advances in the diagnosis, treatment and prevention of disease.[1]

In 1920, Charles-Edward Amory Winslow, defined public health as "the science and art of preventing disease, prolonging life, and promoting health and efficiency through organized community efforts for the sanitation of the environment, the control of communicable infections the education of the individual in personal hygiene, the organization of medical and nursing services for early diagnosis and preventive treatment of disease, and the development of social machinery to ensure for the maintenance of health, so organizing these benefits as to enable every citizen to realize his birth right of health and longevity".[2]

It is very important to consider the development of nanotechnology in the context of public health.[3] The recent emergence of nanotechnology in the marketplace has raised global concerns among scientists, researchers, regulatory agencies, consumers and the general public, regarding its safety. It is expected that nanotechnology will have a major impact on medicine and health care; energy production and conservation; environmental clean-up and protection; electronics, computers, and sensors; and world security and defense.[4]

It is now realized that demands on health care systems will always be greater than the resources available to meet those demands. This dilemma is applicable to all the poorest as well as the richest countries in the world. One response to increasing demands and limited resources is to direct resources to particular problems. However to decide if the problem is important, certain criteria can be used to determine the significance as follows (Sheiham, 1996):[5]

1. Prevalence of the condition
2. Impact of the condition on an individual level
3. Impact on wider society
4. Condition is preventable and effective treatments are available.

The nanotechnology has a potential to deal with the public health problems. The applications of nanotechnology in public health are discussed hereby.

PROTECTING THE HUMAN RIGHT TO CLEAN WATER

Water is essential for life. The amount of fresh water on earth is limited, and its quality is under constant pressure. Preserving the quality of fresh water is important for the drinking-water supply, food production and recreational water use. Water quality can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards. Safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes. Improved water supply and sanitation, and better management of water resources, can boost countries' economic growth and can contribute greatly to poverty reduction.[6]

One specific use of nanotechnology, which can improve public health, is environmental nanotechnology, which can produce clean and safe drinking water for human consumption and use. In the modern world, availability of water continues to be a problem on an international level due to factors like global warming, drought, and unprecedented population growth. Nanotechnology can be used to make water-testing sensors to purify water for safe consumption. This can improve public health on a global level by reducing the numbers of people harmed or killed by health problems associated with unsanitary water. Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio. Some 8,42,000 people are estimated to die each year from diarrhoea as a result of unsafe drinking-water, sanitation and hand hygiene. But diarrhoea is largely preventable, and the deaths of 3,61,000 children aged under 5 each year could be avoided each year if these risk factors were addressed.[7] Furthermore, safe drinking water can help primary education in several developing countries in Africa, Asia, and Latin America, where children are often unable to attend schools due to the lack of clean water sources.[8]

The present market of nanotech-based technologies applied in water treatment consists of reverse osmosis, nanofiltration, ultrafiltration membranes. Indeed, among emerging products one can name nanofiber filters, carbon nanotubes and various nanoparticles. Nanotechnology is expected to deal more efficiently with contaminants which convectional water treatment systems struggle to treat, including bacteria, viruses and heavy metals. This efficiency generally stems from the very high specific surface area of nanomaterials which increases dissolution, reactivity and sorption of contaminants.[9]The practical examples include:

1. Tata Swach - a water purifier developed by Tata Chemicals[10]
2. The Lifesaver bottle- a prototype by Pritchard from lifesaver company[11]
3. LifeStraw - water filters designed by the Swiss-based Vestergaard Frandsen[12]
4. Folia water- silver/copper nanoparticles impregnated water filter papers by Theresa Dankovich and John Smith[13,14]

REDUCING THE GLOBAL DISEASE BURDEN

There are many questions of public health which are not yet being asked about nanotechnology. If nanoparticles are to be used in cosmetics, food production and packaging, how will they react or interact with the human skin and organs? What chemical-toxic effects on life might there be from the nanoparticles in car tires and vehicle plastic mouldings when they are disposed of by incineration? Will they pass into the soil and groundwater and enter into the food-chain? Very few studies of the impact of nanoparticles and nano-devices on the environment, animal and plant life, and the human body have been undertaken so far.[3]

Unfortunately, the role of "nanomaterials" and their interaction with biological processes is poorly understood at this time. Often, but not always, the properties of substances at the nanoscale differ significantly from those on a larger scale. For example, gold is inert in daily life but combustible at the nanoscale. The question whether these differences in chemical properties at the so-called "nanoscale" have any impact on industrial productivity or pose any risk to public health is therefore very important. But, the technology is so new that little is known regarding the potential dangers. Scientists and governments agree that the application of nanotechnology to commerce poses important potential risks to human health and the environment, but the risks are unknown.[8]

Striking a balance between research and development (R&D) of toxic nanomaterials despite unknown risks is a clear and consistent theme of background papers about regulation of nanomaterials.[15] How can nanotechnology affect human health and well-being? Nanoparticles can affect human health and well-being in several unpredictable ways:[4]

1. Nanoparticles can enter the body through multiple routes of entry (inhaled, eaten or absorbed) and can accumulate in novel places.
2. Accumulation of nanoparticles in novel places in the body (intracellular, intercellular, extracellular or in the cell membranes, receptors, organelles, inclusions, etc.) may disturb normal molecular, biochemical, physiological and anatomical functions leading to unpredictable conditions that may lead to cytotoxicity, necrosis, and cell death.
3. Nanoparticles may interact with molecular structures, proteins, enzymes, DNA, RNA in a reversible or irreversible, predicted or unpredicted ways that may cause havoc in biological systems leading to the appearance of new diseases and symptoms never before seen.

What can be done with regards to establishing safety measures for public safety?[4]

1. Adopt the precautionary principle which states that nanotechnology should be proven safe by sound scientific data before released in the marketplace.
2. Petition the Food and Drugs Administration and other similar agencies worldwide to undertake proper risk assessments and to ensure proper labelling.
3. Petition the United States Department of Agriculture and other similar agencies worldwide to undertake proper and comprehensive risk assessments.
4. Petition United States Food Safety and Inspection Services and other similar agencies worldwide to undertake and implement necessary safety standards.
5. Mandatory use of warning labels on all products or devices that contain nanoparticles. Engage and provide funding for continuous research on the safety of nanoparticles. Develop networks for sharing information about nanotechnology, its use and safety among scientists.

CONCLUSION

Nanotechnology is like two-edged sword. If it reaches its full potential, nanotechnology may change the world in fantastic and wonderful ways. However, as with any other technology, it also carries a potential for misuse and abuse. Nanotechnology will give a new visionary to comprehensive health care for improvement of public health.

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