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Nanomedicine: Challenges and Promises for Public Health Future

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Abstract--- *With the advancement of the scope applications of nanotechnology in medicine, it is important to identify and advance relevant contributions to public health at the same time. A broad range of nanomedicine advances promise to affect each medical specialty and reveal new ways to improve efficiency and prolong the lifetime-these improvements can be calculated at both population and individual levels. For instance, combined heart disease and cancer make up roughly half of all deaths, and developments in nanomedicine now show great potential to reduce morbidity and mortality rates related to these diseases. Meanwhile, the public health nanomedicine applications such as portable and rapid diagnostics and more efficient vaccinations have the ability to transform global health. Innovative science in fields such as biology, engineering, medicine, and public health will work together to achieve maximum possible health impacts for populations and individuals. In addition, gaps in information regarding the possible health and safety effects of exposure to the engineered nanomaterials need to be discussed and vigorously explored. Nanomedicine will be powered by innovative, constructive and socially responsible work as it plays an increasingly important and disruptive role in 21st century in medicine and public health.*

Keywords--- *Environmental Health, Epidemiology, Nanomedicine, Nanotechnology, Public Health, Vaccinations*

I. INTRODUCTION

Nanotechnology applications in disease diagnosis, screening and treatment are collectively referred to as "nanomedicine" - a new field that has the ability to revolutionize population and individual based health[1]. Whereas clinical practice promotes health at individual basis, the public health mission is to encourage, protect, and maintain health for groups of individuals or populations. To optimize the gains and minimize potential risks to the greatest number of people, studying and investigating the potential applications and effects of the nanomedicine through public health lens is important. The attraction of nanotechnology applications resides in the unique features and anomalies that occur due to their small scale. In nanotechnology the most widely accepted definition of scale is 1–10.0nm[2]. Engineering materials on such a scale allow for novel medical therapies like the production of drugs based on nanoparticles that target the cells with improved precision, resulting in reduced side effects for patients. Further advancements are being developed in medical devices and instruments for use in less invasive surgical procedures, resulting in faster recovery times and lower risk of post operative infections or other risks[3]. These developments can improve quality of life, extend life expectancies and may decrease overall healthcare costs.

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Implementation of the nanomedicine into daily clinical practice will pose numerous obstacles for a variety of reasons from regulatory agencies, related public groups insurance companies and others. Collaboration between those who have a strong interest in the advancement of nanomedicine must be empowered to address these obstacles at an earlier stage[1], [2]. Potential nanomedicine work as well as clinical and population-based deployment should be influenced by public health experts as an essential part. Their roles will vary from collecting and analyzing epidemiological data on the effectiveness of the nanoenabled medications to campaigning for expanded research funding. The areas of nanomedicine and public health should strengthen each other with proper due diligence and coordination in a number of ways to improve the human health more quickly than either can do independently[4]. The goal of this paper is to educate stakeholders group that includes the general public, government, industry, and academics interested in advancing nanomedicine on principles of public health which should be actively integrated into the study, implementation and development of this fast-growing field.

I.I. Public Health

Nanomedicine is capable of having effects on all areas of public health. Public health is described as "the science and art of disease prevention, prolonging life, and fostering safety and quality through concerted community effort"[5]. This often involves city-wide or population-based initiatives such as infectious disease control, public health, and early screening and identification clinical preventive services. Through coordinated activities that affect communities of people as well as persons, public health seeks to improve the health of each person in a community. According to Association of Schools of Public Health, the field of the public health is subdivided into the following five main disciplines[4]:

- Epidemiology
- Biostatistics
- Health policy management
- Social and community behavior
- Environmental health sciences

Epidemiology is the study of factors, and disease distribution. It articulates with biostatistics and analyzes the factors and disease distribution in quantitative terms. Health policy and management utilizes information from medical and public health disciplines to create regulations, laws, and guidelines for public health good[4], [5]. Environmental health aims on how human health is influenced by the social and physical environment, and how people impact their surroundings. Through these key areas, the knowledge base gained provides a platform for the public health experts to analyze, appreciate and forecast the effects of nanomedicine on population health.

I.II. Environmental Health

To proactively investigate, it is critical to understand the environmental and human health effects of the engineered nanomaterials, products, and by-products, and methods involved in creating them. Early-stage research suggests that some nanoparticles might be more vigorous in the environment than others, emphasizing the need to gather more information about risk management and assessment[4]. While there are already more than 1I000 nanoenabled consumer products available in the market, there are gaps in knowledge about their fate and transportation within humans, atmosphere and ecosystems. For examples, many topical creams like sunscreens already on the market involve

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titanium dioxide nanoparticles. Sunscreen products containing nanoparticles include Banana Boat I®, Burt's Bees I®, Coppertone I®, and many more[6]. Such materials are meant to be used directly on the skin where some of the substance is absorbed through the epidermis and few are cleaned or brushed off and inserted into municipal drainage systems.

Nanosilver is another particle of concern due to its inherent antimicrobial nature and ability for altering the treatment environment for wastewater. Water treatment plants weren't designed specifically for nanoparticles elimination. Examination of the entire life-cycle of manufactured nanomaterials, from their raw materials to processing, is a vital part of developing nanotechnology safely from a health and safety point of view[3], [4]. As the number of products incorporating nanomaterials continues to rise on the market, there is greater awareness and concern about their impact on the environment. Likewise, nanoparticles used for medical procedures will have multiple entry points into environment based on their specific application, role and disposal. This could include excreted nanoenabled drug ingredients into soil, recycling of novel imaging chemicals, and end-of-life medical devices inside a landfill[7]. The EPA and FDIA are currently providing guidance to the public on how to dispose of unused medicines, as certain drugs have the ability to change the wastewater treatment system. So understanding how nanopharmaceuticals would also affect water quality is important. Continued research is needed to understand the impact on the environment of nanomaterials across all phases of their life-cycle[8].

I.III. Epidemiology and Biostatistics

Epidemiological study is a powerful tool used to monitor determinants of health and disease spread in communities in order to manage health problems. Biostatistics that is defined as applying statistical methods to medical and biological problems is complementary to epidemiology. Studies in these areas uncovered associations between conditions and health outcomes that dramatically altered the practice of medicine and public health[4], [8]. Epidemiological investigations range from exposures to the environment that may result in a certain disease, or a new medical intervention that may decrease the incidence of a specific disease. Together with biostatistics, epidemiologists should track the effect that technologies of nanomedicine will have on particular health results of concern as well as overall population health. This would include comprehensive studies of nanoenabled drugs post-market surveillance to track their health as well as their efficacy[9].

When technologies for nanomedicine become more common in clinical care, knowledge about how they affect health outcomes can help insurance companies make choices based on cost-benefit analysis of modern and current medical interventions. That could potentially drive down the healthcare spending[4], [5]. This surveillance data, in effect, will highlight areas of the medical research requiring applications in nanotechnology. Communication with federal agencies of where those discrepancies exist should ensure that money is distributed to the most potential impact areas. Epidemiological observation of where technologies of nanomedicine are mainly used can reveal whether there is equal distribution between different populations in different parts of the world. These aspects are important elements in guiding future applications of nanotechnology in health and medicine, as well as the public policy, ethical and societal implications[4], [8].

I.IV. Health Policy Management

The two main components that will be influenced by nanomedicine as regards public health policy and management

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are healthcare delivery systems and regulatory agencies. The FDA's duty is to protect public health by ensuring that there is protection for human products, cosmetics, medical supplies, national food sources, and drugs[10]. The FDIA has not actually established specific regulations for nanomaterial-containing products; however, certain products that contain engineered nanomaterials come within its authority. This varies from sunscreens to prescription medicines which raise public and lawmakers' concerns. The FIDA is not limited to the task of controlling engineered nanomaterials[4]. One major challenge facing these organizations is the shortage of nanomaterial standardization. The complex complexity of nanomaterials doesn't really apply itself well to the standard chemical nomenclature.

Nanomedicine developments will also have an impact on health care delivery systems. Screening modalities with greater sensitivity and disease diagnosis accuracy may significantly improve the prognoses and reduce the cost of health care. Initially, insurance providers may oppose paying for certain treatments using nanomedicine[10]. New technologies are sometimes more costly than conventional medical treatments and, although the new methods can be more successful, implementation is often resisted. This is a problem that will be solved with time and enough evidence to clearly show the effects of emerging nanomedicine technologies in disease diagnosis, prevention, and treatment[3]. Healthcare providers and delivery systems can face financial difficulties because they will bear the initial cost of buying new equipment and spending time learning about developments in nanomedicine to integrate them into the clinical practice. Such actual as well as potential obstacles should be resolved by a collaborative effort of all parties involved[9]. Public health officials will play a key role in collaborating with experts who are designing the technologies to transparently distribute risk, cost and benefit knowledge to those who will adopt it.

I.V. Training

Medical practitioners, public health professionals, and science researchers involved in the production and operation of the applications in nanomedicine should be familiar with the fundamental concepts and principles of public health as they pertain to new technologies. This will push work in a direction that will affect population health most effectively and encourage effective communication and cooperation among business, government and academia stakeholders[11]. There will be many different types of specialists in the group tasked with developing nanomedicine, which will involve true interdisciplinary collaboration. Public health professionals will need to be acquainted with the principles of nanotechnology to help implement new nanomedicine technologies into healthcare systems[12].

Public health practitioners should be informed on the growing nanomedicine sector and its consequences for the health of the population. This can be achieved by various strategies such as raising the knowledge base by publishing nanomedicine publications targeted at public health audience, integrating sessions into major conferences such as the annual conference of American Public I Health Association, and delivering lectures and courses dedicated solely to teaching public health professionals about advances in the public health[10], [12]. Those interested in strategic planning of the development of nanomedicine within government, industry and academia should then realize its capacity for public health effects.

Training and education would need to take place in a cyclic way among all groups Public health experts need to know about nanotechnology and its advances in medicine in order, in addition, to educate medical professionals and researchers on its national and international effect on the population health[8], [9], [11]. This will include relationship development across fields and markets, resulting in more effective integration of technologies into patient care, which

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will potentially improve outcomes for person and population health.

Furthermore, a new generation of physicist scientists who are educated in both medicine and nanotechnology will push new developments in nanomedicine into effect. As the art and science of medicine progresses increasingly in the face of cutting-edge technology, the application and enhancement of the potential impact of these developments on human health requires a new generation of scientific investigators[4], [7]. A fully hybrid population will play an integral role in moving clinical nanomedicine translation work from bench top to bedside. A strong educational base, a skilled workforce, a state-of -art research and development system is important in this area, according to the National Nanotechnology Initiative[5], [6].

To create a new generation of inventors and researchers working at the nanoscale, engineering, science, and technology programs and resources are needed. Similar initiatives should include the creation of educational modules which include nanotechnology in syllabuses for many disciplines that contribute to nanotechnology[4], [10]. Several strategic federal initiatives and national groups, including National I Cancer Institute I Alliance for Nanotechnology, particularly call for the training programs intended to develop next generation of the nanomedicine researchers and support young people to chase cross-disciplinary careers in medicine, science, and engineering[10].

II. CONCLUSION

To improve the health, the opportunities for nanomedicine are infinite. To exploit gains in population and individual health, inclusion of the public health skill is necessary. This role in nanomedicine growth will help to determine the main fields of technological innovation need, decide how best to allocate the money, and form policies to protect people and the environment. An important aspect of advancing nanomedicine is the expansion of the cross-disciplinary training in government, industry, and academia for health care providers, researchers, and public health professionals. Taking collaborative strategy to research and education in nanomedicine would better advance the state of the science, leading to a greater return for public health on investment. The research and development of new applications of nanomedicine incorporated with the public health principles may revolutionize human health throughout the world.

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