Nanotechnology in Medical Practice

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ABSTRACT

In recent years, the interest in the concept of nanotechnology has grown and its applications in other sectors, such as the electronics sector, have met with tremendous successes. This discovery has prompted the introduction of this concept in the medical sector to aid the development and improvement of medical practice. In this paper, a study was conducted to investigate the influence of nanotechnology on medical practice. The study was conducted using a quantitative approach by designing a questionnaire as the data collection instrument. The survey involved 77 medical practitioners within Coventry, England using stratified random sampling technique. The results however show that stakeholders are really interested in ensuring that nanotechnology is used to tackle the problems of medicine. However, the concept needs to be fully funded so as to achieve its full potential not only in medicine but in every facet of human life.

(Keywords: nanotechnology, medicine, medical practice, stratified random sampling survey)

INTRODUCTION

Nanotechnology is today considered as a cutting-edge concept in the minds of all stakeholders in the technology industry, and like its progenitor – biotechnology, the concept of nanotechnology is yet to be comprehended and fully accepted in the world today. This occurrence can be likened to the understanding that no singular innovation in terms of devices and sub-devices has been wholly manufactured using the concept of nanotechnology. What has been obtained in the world today are innovations that consist of parts that are produced using the concept of nanotechnology.

With the dynamism of semi-conductor based technologies, advances in the area of biology and physics (molecular) have given molecular engineers, researchers, and scientists several research ideas and opportunities which have presented us with the era known as the Nanotechnology Era [1].

Nanotechnology simply involves the creation of a set of functional materials, systems, and devices that possess novel properties, through the control of matter at the given nanoscale of 1 to 100 nanometers. This definition is widely accepted and is the most common description of nanotechnology [2].

The concept of nanotechnology has employed the use of micro-electric technology to produce devices whose initial sizes have been reduced such as computers which now have pocket sizes as compared to the conventional desktops and laptops. This technology has been used in manufacturing devices that have the ability to manipulate discrete molecules and atoms in exactness and this approach has been explained as technology at the molecules level which is also described as nanotechnology [3]. Nanotechnology can further be described as a composition of the understanding and utility of substances which can be produced or technological ideas that can be put to use to produce objects, devices or substances at the nanoscale, and the manipulation of the molecular elements that make up the manufactured devices [4].

Nanotechnology in medical practice presents revolutionary opportunities in the fight against many diseases. It has the potential of detecting molecules associated with diseases such as cancer, diabetes mellitus, neurodegenerative diseases, as well as detecting micro-organisms and viruses associated with infections such as pathogenic bacteria, fungi, and HIV viruses. For

example, in the field of cancer therapy, promising novel nanoparticles will respond to externally applied physical stimuli in ways that make them suitable therapeutics or therapeutic delivery systems [5].

While it is notable that most of the nanotechnological breakthroughs of this modern day have been most visible in the medical field, it must be noted that most of these applications are still in the development stage while some of them are only mostly utilized as agents or subagents in healing tumors, performing surgery, and also as an antimicrobial agents. Most of the research efforts around the world are involved in the development of nanoproducts that are aimed at advancing research in medicine and generally improving health care amongst individuals [6].

This main objective of this study is to conduct an investigation into the influences of nanotechnology in the medical field so as to allow for the outlining of strengths and limits of this technology to medicine. Also the study identifies the numerous aspects of this technology that will be of tremendous benefits to the medical field in the nearest future.

NANOTECHNOLOGY IN MEDICINE

The term medicine is solely concerned with the diagnosis and care or cure of diseases and illnesses. Curing a disease could be only on the short term basis such as the process of a surgery or until nature's form of cure can take effect. Nanoscience is a broad field that encompasses almost all spheres of technology. Hence, the medical aspect of the nanotechnology field is one of the most potentially valuable, which is projected to have many benefits to mankind. Human cells themselves are very complex and productive nano-machines which biochemists have been working on for quite some time now at a nanoscale without making use of the nano label [7].

Nanomedicine has shown to have a large potential, primarily in the area of diagnosis, hence the use of biomaterials has been utilized to achieve this goal. Over the last few decades, medicine has exploited the use of biomaterials in conducting investigation and caring for patients infected with myriads of diseases. Some very common examples of this utilization are surgical procedures and orthopedic hip replacements, vascular grafts, and implantable pumps. It is also imperative to lend a definition to biomaterials. Greco et al, 2005 defined biomaterials as *"A substance that is been manufactured by a living organism* [8]. Another definition to biological materials was offered by the National institutes of Health Sciences as captured in a text by Greco et al. They further explained biomaterials as; "*Any substance other than a drug, or combination of substances, synthetic of natural in origin which can be used for a period of time as a whole or as a part of the system that treats augments or replaces any tissue organ or function of the body"* [8].

The use of nanotechnology for medical diagnosis can be achieved through the use of mechanical nanorobots, although they are still in the formulation stage. Another form of nanorobots, namely, chemical nanorobots, is an efficiently smart drug that has the potential of rewriting DNA sequences and also repairing damaged brain or important organ damage when it is injected into the human body [9]. The human respiratory system has also witnessed the strengths of nanotechnology. Nanotechnology has come up with a tool known as the respirocyte which can be described as an artificial red blood cell which is similar in size to a bacterium that has the ability to deliver enough needed oxygen to the human respiratory stream. This tool is also very useful in the treatment of patients that are diagnosed with poor lung capacity.

According to Robert Freitas [10]**,** the 21st century manufacturing technology (i.e., nanotechnology) has allowed for the production of a wide range of sophisticated molecular machines and molecular computers. This technology has enabled researchers and manufacturers to build sets of computer controlled molecular devices that are smaller than a human cell and this is constructed with the exactness of drug molecules. These computer controlled devices will allow medicine to mediate in a complex and controlled manner at the molecular and cellular level [10].

Examples of such tools are sensors that are smaller than a cell which will give us an impeccable and precise look at continuous functions [11]. Nanotechnology can also provide us with devices that analyze tissues that are chemically fixed literally down to the molecular level providing a totally detailed snapshot of cellular, sub-cellular and molecular activities [11]. This process also termed as nanoendoscopy as

explained in [12] enables the viewing and extraction of biological tissues down to a nanometer scale of singular copies of DNA. Nanotechnology has also benefited medicine in the area of forensic science by working at a bionanoscale. According to Thalhammer and Wolfgang in [12], they explained that the combination of laser cutting, using atomic force microscopy tip to serve as a nanoextraction tool enables for totally new sample generation and more biochemical processing. The above illustration is a one of the areas that typifies the influence of Nanotechnology in medical science. Atomic force microscopy is a tool used for high resolution imaging of surface topography of genetic material, but at the same time it is a useful tool on the nanometric scale.

Nanotechnology has been an integral part of medicine because of its numerous strengths and capabilities. For example the autonomous molecular machine has the ability to monitor levels of compounds in the human body and also keeps information in the internal memory. This machine can enable the determination of the location and time of these compounds in the human body after the analysis of the blood sample from the machine [11]. The results from the analysis provide a picture of events within the very healthy and injured tissue. However, obtaining this knowledge will give a researcher or medical practitioner insights and new methods to curing an ill patients and caring for the injured ones [11].

The concept of nanotechnology is also of particular importance and value to biomedical applications since it has been able to provide means by which consultants can prevent human cells from binding up to a particular surface in the human body [10]. However, there is a distinct confluence between the term nanotechnology and the field of medicine. Nanotechnology has formed a nucleus of medicine by the provision of technologically minute tools and technology platforms to enable the conduction of concise investigation and transformation of biological systems while medicine has provided models of inspiration and biologically assembled parts to nanotechnology. In the light of this, it is observed that nanotechnology complements medicine in numerous ways.

RESEARCH METHODOLOGY

The research design plan contains clear objectives, derived from research question(s), specify the sources from which data are to be collected, and consider the constraints that may arise, such as access to data, time, location and money, as well as discussing ethical issues [13]. This study employed the use of the tri-staged method so as be at par with the principles of triangulation. The triangulation approach will ensure the credibility, conformability, transferability, and dependability of data. This research made use of questionnaire that was given to medical practitioners within Coventry, England.

The amount of data needed to be collected by acquiring data from only a subgroup rather than an entire population is made possible by the use of sampling techniques that provides a range of methods to achieve this [13]. The sample population of this study involves 70 health workers as respondents. Thus, 57 respondents eventually participated in the survey. These were used to get responses to this research's questions and carry out the analysis.

Due to the limited time involved in carrying out this research, it was not possible to carry out the survey on the large population. However, a sample out of the total population was used. Sampling which is mostly used by researchers using the quantitative research method is a process where a representative sample or a small collection of population from a larger population is drawn, such that the sample information enables the researcher to study the smaller group and produce accurate generalization about the larger group [14][15].

Furthermore, [14][15] stated that researchers have two motivations for using the random sampling; the first motivation being that it saves time and cost. Secondly, the purpose for using the random sampling is accuracy (i.e., a well-designed and executed sampling can produce accurate results than trying to acquire data from all employees within the Health centers).

RESULTS AND DISCUSSION

The Funding and Cost of Health Care Delivery

Questions 1 and 2 were used to sort answers from the respondents on the funding and cost of health care delivery using nanotechnology equipment.

Q1. Looking at the exploits of nanotechnology, do you think nanotechnology has been adequately funded worldwide?

Q2. Will nanotechnology make health care more expensive for the less privileged?

In all, 20 respondents strongly disagreed with the funding status of this technology today. It shows that stakeholders are eager to see more adequate investment in the area of nanotechnology especially in medicine. This survey was mostly distributed to medical personnel including doctors, nurses, and medical consultants. Another set of 18 respondents also disagree though not strongly but it shows the need for extensive funding in the area of nanotechnology.

The second survey question in turn returned interesting responses showing that stakeholders agree that the concept of Nanotechnology will make health care delivery expensive to the less privileged. Therefore it will be imperative to all concerned in the implementation of Nanotechnology in medicine to ensure that the end products of this concept will not in any way make health care to go out of the reach of the common individuals. Figure 1 shows the statistics of responses from respondents.

Knowledge Capacity of Medical Practitioners

Figure 2 shows respondent's view of the knowledge capacity of medical practitioners in the view of the concept of nanotechnology. As shown, stakeholders are of the view that most doctors have an idea of application of application of nanotechnology medical practice but with little or no knowledge of how they are manufactured.

The third question also shows that there will be an enormous capacity building power in the concept of nanotechnology to medical personnel as result of unending partnership with researchers and manufacturers alike. Thirty respondents agreed that it will improve the knowledge base as indicated in Figure 2. The following questions were used to sort answers to the knowledge capacity of medical practitioners.

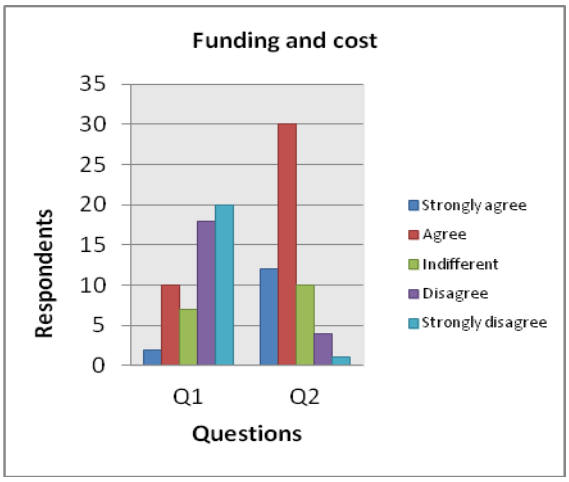

Figure 1: The Funding and Cost of Health Care Delivery

Q3. Nanotechnology will improve the knowledge base of medical practitioners

Q4. Most medical practitioners or consultants are technologically knowledgeable

Q7. Medics have the needed information to understand the concept of nanotechnology

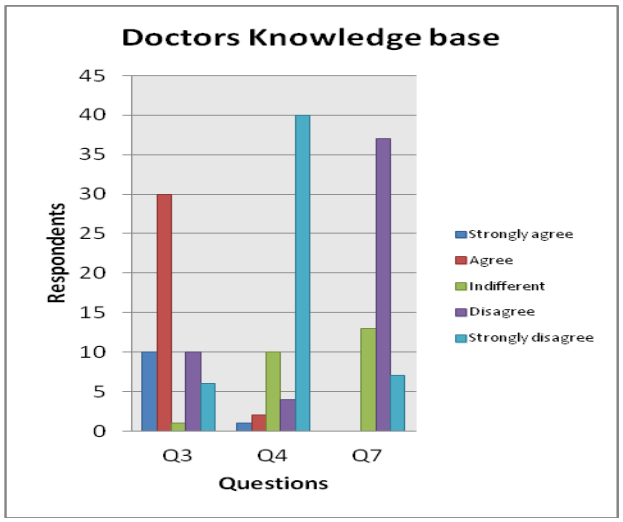

Figure 2: Doctors' Knowledge-base.

Attitude of End Users and the Availability of Nanoproducts

The level of response indicates that most patient either as a result of ignorance or the desire to get cure for their illnesses never bother to ask questions about the equipment that are been used to examined them. The chart shows that in response to Question 5, patients have little or no knowledge about the equipment used in examining them; they just want to be diagnosed and get their results thereafter.

Also in response to Question 14, responses show that swift and immediate health care delivery will enhance living standards in economies as a result of the expectations from nanotechnology. The availability of nano-products is still a debate as the fear of cost and monopoly on the side of manufacturers may in many ways hinder the accessibility and availability to end users and in some cases, some health institutions in some countries. Question 5, 14, and 15 below were used to sort answers to this.

Q5. Ordinary individuals or patients understand the concept of nanotechnology

Q14. Nanotechnology will improve living standards around the world

Q15. Medical devices of nanotechnology are user friendly and readily available

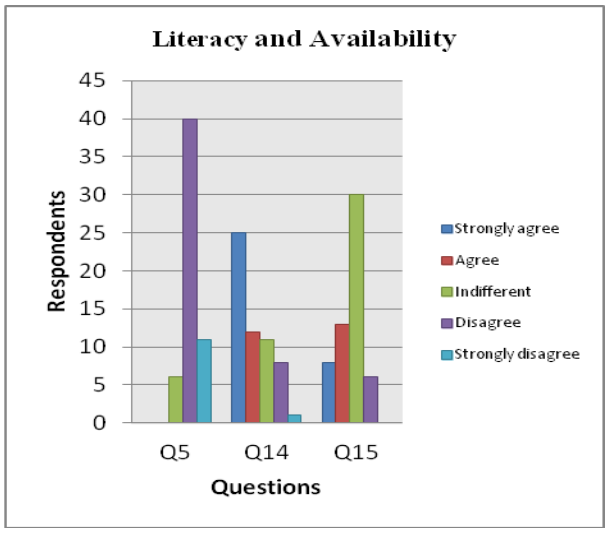

Figure 3: Literacy and Availability.

The Use of Nanotechnology in Medicine

This is the most interesting part of the survey as it is indicative of the effect of Nanotechnology in medicine. Surprisingly it came in with results showing that the concept has been of tremendous influence to the medical practice. According to the survey statistics shown in the chart and table below, it shows that practitioners find nanodrugs very effective and faster than normal macro-drugs. Also, there is a wide clamour for the introduction of nanotechnology in every aspect of medicine. The survey also shows that the effect of nanotechnology will be felt on the environment, especially in the area of reducing the emission of carbon to the atmosphere. Figure 4 shows the statistics of responses. The following questions were used to obtain the statistics:

Q8. Nanotechnology will make a whole lot of difference in medicine.

Q9. Nanotechnology will affect the environment positively

Q10. Nanotechnology will improve health care delivery rapidly

Q11. There is need for the introduction of nanotechnology in every area of medicine

Q12. Nanodrugs are of more effect than normal macro drugs

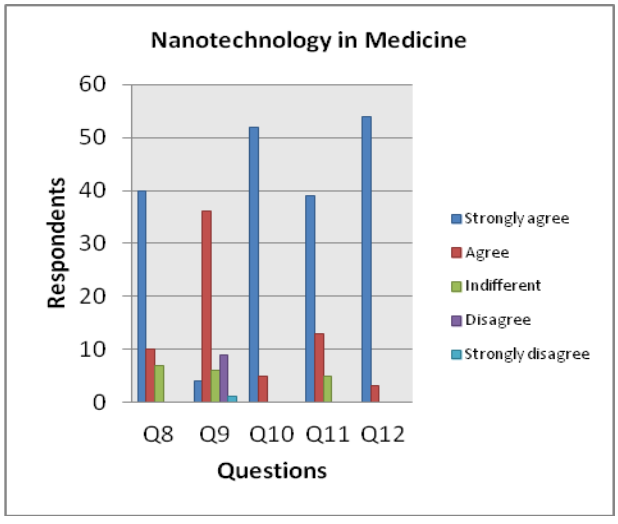

Figure 4: Nanotechnology in Medicine.

Availability of Nanotechnology Infrastructure

The high indifference to question six shows the non-availability of information regarding the infrastructure base of Nanotechnology. Question 13 shows that economies around will benefit tremendously from the concept of Nanotechnology. Respondents agree that the growing desire of governments in seeing to a large influx of minute and environmentally friendly products will aid more returns to the coffers of governments around the world. Figure 5 shows the frequency of response as regard Q6 and Q13.

Q6. Nanotechnology in the world today has enough needed infrastructure

Q13. Nanotechnology in medicine will be of great benefit to economies around the world

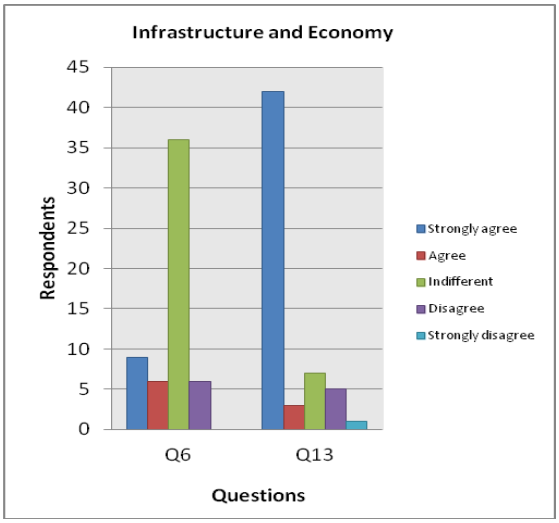

Figure 5: Infrastructure and Economy.

CONCLUSION

This study confirms that nanotechnology has been influencing medical practice positively with innovative solutions and ideas to tackling the menace posed by diseases and illnesses. The survey also shows the necessity of introducing the concept of nanotechnology in every area of medicine. It can be conclusively said from the above analysis and the thorough investigation of case study that stakeholders are really interested in ensuring that nanotechnology is used to tackle the problems of medicine. It can be said also that the concept needs to be fully funded so as to achieve its full potential not only in medicine but in every facet of human life.

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SUGGESTED CITATION

Oladimeji, O.D. and A. Adedoyin. 2018. "Nanotechnology in Medical Practice". *Pacific Journal of Science and Technology*. 19(1):281-287.

Pacific Journal of Science and Technology