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# NANOMEDICINE: FATE AND FORTUNE IN FUTURE *TO TAILOR A DEVICE AT A BILLIONTH OF A METER, ABOUT HALF THE WIDTH OF A DNA*

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## ABSTRACT

The field of nanomedicine applies the various applications of nano technology in the diagnosis and treatment of diseases. This new field has promising applications in the near future. This article will highlight the importance of nanomedicine and its various applications for the benefit of mankind.

**KEYWORDS:** Nanomedicine – Nano Technology - Applications

## INTRODUCTION:

Nanotechnology is an idea that most people simply didn't believe as it is a broken technology. Pharmaceuticals, robotics, artificial intelligence, nanotechnology – all these areas where the progress has been a lot more limited than people think (Varshney, *et al.,* 2012) and the question is why? Nanotechnology will let us build computers that are incredibly powerful. We'll have more power in the volume of sugar cube than exists in the entire world today (Silva, 2010) Nanotechnology in medicine is going to have a major impact on the survival of the human race. Their function is mainly by interfering with the biological molecules or structures since their sizes are much more comparable. Though the nonmaterial's are the significant part of *in-vivo* and *in-vitro* biomedical research, they are still in Preliminary stages of testing and no curative product of remedy in medical field is commercially available (Bleve *et al.,* 2011). Thus far, the integration of nanomaterials with biology has led to the development of diagnostic devices, contrast agents, analytical tools, Physical therapy applications and drug delivery vehicles.

## PRE –HISTORIC SIGNIFICANCE

About 10.000 years ago, an ancient system of medicine called Siddha which was organized and practiced by a group of 18 siddhars or spiritual saints has been believed to have developed the most anticipated medicinal practice of nanomedicine (Paul and Chugh, 2011). Herbs and minerals are the integral part of this medical practice. The Precise Preparations of these Medicines had made them very minute and very effective when given in accurate but potent dosage forms. Termed as 'Bhasma' these medicines preliminary lacked scientific and experimental evidences, recent improvement in analytical methods have shown supporting results in TEM and FTIR analysis (Pal *et al.,* 2014). With good encouragement from government and support from general public, the practice seem to gain good reputation in the scientific world in future.

## ORIGIN

Traces of nanomedicine's origin is from Richard Feynman at Caltech in 1959 – *There's Plenty of Room at the bottom* where he proposed the idea of chemical manipulation at the atomic level and suggested that patients might one day " swallow the Surgeon" in the form of tiny machines. In 50 years, a wide list of nanomedicine applications being developed today.

Of course, the reality of nanomedicine doesn't exactly fit Feynman's fantasies. The silicon chip boom of the 1980's gave chemists the technology they needed to manipulate substances at the nanoscale. But chemists weren't necessarily thinking about biomedical applications when they first started working with nanomaterials. "People were playing around with matter partly because they could, "say Paul Aliviasatos, Chemist at the University of California, Berkeley and a pioneer in nanotechnology (Weiss *et al.,* 2006). One of most famous discoveries of this exploratory period was the buckyball, a carbon nanoparticle with a unique geodesic-like structure that earned its discoveries the 1996 Nobel Prize in chemistry, even though it wasn't obvious at the time that would be any real-world application for so called fullerenes (CEA/CNRS Joint Press Release, 2003). Today fullerenes are being developed as drug carriers and for other nanomedicine application (Zhou *et al.,* 2007)

## MEDICAL APPLICATION

### Drug Delivery and Potential Practices

Nanomaterials have made their way into drug – delivery systems and diagnosis and are quickly becoming essential basic research tool. Nanotechnology has provided the possibility o delivering drugs to specific cells of animals using nanoparticles. Due to their small size and less invasive strategy, they can be implanted inside the body of the animals. (Kotrotsiou *et al.,*, 2005)

The efficacy of drug delivery through nanomedicine s largely based upon:

- Efficient encapsulation of the drugs (Ortwine, 2009)
- Successful delivery of drug to the targeted region of the body (Linnerweber *et al.,* 2014)
- Successful release of the drug (Bleve *et al.,* 2011; Garg *et al.,* )

Drug delivery focuses on maximizing bioavailability at specific places over a period of time (Garg *et al.,*). However, the pharmacokinetics and pharmacodynamics of nanomedicine is highly variable among different patients (Varatak and Gemeinhart, 2007), When designed to avoid the body's defence mechanisms, nanopartices have beneficial properties that can be to improve drug delivery (Varshney *et al.,* 2012)

### Sensing and Visualization

*In vivo* imaging is another area where tools and devices are being developed (Bawarski *et al.,* 2008) nanoparticles contrast agents and their images such as ultrasound and MRI have a favourable distribution and improved contrast which was accomplished by self assembled, biocompatible Nanodevices that can detect evaluate, treat and report to the clinical doctor automatically (Mills and Needham, 2006).

Another major development in medical by introduction of nanotechnology is for sensing in more than one dimension for analysis (Datta and Zentner, 2006). With just few drops of blood or tissue sample, sensor test chips which have thousands of nanowires will be able to detect proteins and other biomarkers left behind by cancer cells which intern could enable the detection and diagnosis of cancer in the early stages (Martis *et al.,* 2012) Magnetic nanoparticles, a suitable antibody can be used for the labelling (Jason advisor and Yu, 2013)

Also, gold nanoparticles Tagged with short segments of DNA can be used in genetic sample detection (Asharf *et al.,* 2015). Not to forget the multicolour optical coding biological assays using different sized quantum dots into polymeric micro beads (Kamila *et al.,* 2015). Recently nanopore technology for nucleic acid analysis converts string of nucleotides directly into electronic signature( Albrecht ,2011)

**Tissue Sanitization and Engineering**

Similar to visualization and sensing operations, magnetic micro particles are proven research instruments for the cell and protein separation for the complex media or even removal of various noxious compounds including toxins and pathogens from whole blood in an extra corporeal circuit similar to dialysis which was termed by researchers as magnetic activated cell sorting or dynabeads ( Chidambaram *et al.,* 2011, Colli 2013, Sahoo *et al.,* 2007) based on the functionalized ironoxide and carbon coated metal nanoparticles with ferromagnetic super paramagnetic properties, these beads act as binding ligands covalently

Also new approach to reproduced or repair damaged tissue using suitable nanomaterial-based scaffolds and growth factors is under way that. Nanoparticles such as graphene, carnon nanotube, Molybedenum Disulphide, Tungston Disulphide are being used as reinforcing agents to fabricate mechanically strong biodegradable polymeric nanocomposites for bone tissue engineering applications (Honors ,2013) Potentially these Nanocomposites may be used as a novel, mechanically strong light weight nanocomposites as bone implants in animals more recently, nano nephrology utilizes nanomedicine for kidney for welding arteries. The experiment was demonstrated with two chicken pieces fused together using Au-nanoparticles activated by Laser (Wishart 2016).

**Industrial Significance**

Nanomedicine is a large industry with sales reaching $ 6.8 billion in as early as 2004 and with over companies and 38 products worldwide, a minimum of $3.8 billion in nanotechnology R & D is being invested every year (Cientifica Ltd, 2007). More recently, the global nanomedicine market reached $ 43.2 billion 2010 and $ 50.1 billion in 2011. The market is expected to grow to $ 96.9 billion by 2017 at a compound annual growth rate (CAGR) of 14.1% between years 2011 and 2017. In April 2006, the journal Nature Materials estimated that 130 nanotech –based drugs and delivery systems were being developed world wide (Perez rrero – Medarde, 2015) as the nanomedicine industry continues to grow, it is expected to have a significant impact on the economy (Summary and Genes, 2010). A report states that the implications of technology and commercial trends in the context of the current size and growth of the pharmaceuticals market, both in global and local terms projected to rise over every year quarter. The nature and structure of the nanomedicine industry has proven to add more 60+ companies in recent future (Mayer Brown, 2009; Ratikia *et al.,* 2012).

**Environmental Impact and Ethical Perspective**

One most neglected aspect of nanomaterials is what happens after the prescribed use and low and nonetheless not be ignored residues of nanomedicine enter the environment which could have unexpected effects in the atmosphere because it has been the case for conventional medicine, for which a rapidly increasing number of laboratory studies show Eco toxicological effects (Epa, 2007; Hauptman and Sharan, 2006; Uckun, 2011). However to the best of our knowledge, no study or *in-vivo* and *in-vitro* experiments exploring the environmental effects and hazard identification strategy of nano medical products has been published to date they are now been documented in a number of monitoring studies of conventional Pharmaceuticals in wastewater, surface water, ground water and drinking water (Burns, 2009; Kayser *et al.,* 2005)

**Scope for the Future**

Nanotechnology is beginning to the change the scale and methods of vascular imaging and drug delivery (Sahoo *et al.,* 2007). Indeed, the NIH roadmap's 'Nanomedicine initiatives envisage that nanosclae technologies will begin yielding more medical benefits within the next 10 years (Directorate – General for Research and Innovation, 2013). This includes the development of nanoscale laboratory-based diagnostic and drug delivery platform devices such as nanoscale cantilevers for chemical force microscopes, microchip devices, nanopore Sequencing etc. The National Cancer Institute has related programs too, with the goal of producing nanometer scale multifunctional entities that can diagnose, deliver therapeutic agents and monitor cancer treatment progress (Early, 2008). These include design and engineering of targeted contrast agents that improve the resolution of cancer cells to the single cell level and nanodevices capable of addressing the biological and evolutionary diversity of the multiple cancer cells that make up a tumor within an animal.

## CONCLUSIONS

Thus for the full *in-vivo* potential of nanotechnology in targeted imaging and drug delivery to be realized, nanocarriers have to get smarter, Pertinent to realizing this a clear understanding of both physicochemical and physiological processes. These form the basis of complex interactions inherent to the fingerprint of a nanovehicle and its microenvironment. Inherently, carrier design and targeting strategies may vary in relation to the type, developmental stage and location of the disease. Toxicity issues are of particular concern but are often ignored. Therefore, it is essential that fundamental research be carried out to address these issues if successful efficient application of these technologies is going to be achieved. The future of nanomedicine will depend on rational design of nano technology materials and tools based around a detailed and through understanding of biological processes rather than forcing application for some materials currently in vogue.

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