WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.074
Volume 7, Issue 9, 1685-1695. Review Article ISSN 2277– 7105

NANOETHICS – AN IMPERATIVE IMPLICATION FOR RISK GOVERNANCE IN INDIA

Sujana Papani[1]* and Saivenkatesh Korlam[2]

[1]Department of Botany & Biotechnology, P.V.K.N. Government College, Chittoor, A.P.

[2]Department of Botany, Govt. Degree College, Puttur, Chittoor(Dt). A.P.

Article Received on
19 March 2018,

Revised on 09 April 2018,
Accepted on 30 April 2018,

DOI: 10.20959/wjpr20189-12213

***Corresponding Author**
Sujana Papani
Department of Botany & Biotechnology, P.V.K.N. Government College, Chittoor, A.P.

ABSTRACT

Nanotechnology is a new category of knowledge intensive enabling technology, an amalgamation of various disciplines to engender innovative process and products that has revolutionarized many aspects of modern life by making remarkable impacts in the field of medicine, engineering, environment, economy and even politics. In essence, in countries like India, this technology gained prominence mainly to provide large influx of funds for research to address urgent societal basic needs like water purification, health care etc. Despite the awesome potential benefits, there are foretold latent risks which need to be seriously examined before incorporating nano products and processes in to the society. However, a wide range of ethical issues like, privacy, valu conflicts, accountability, intellectual property rights, non discrimination, equity, hype, self-replication, Cyborgs, socio-economic issues raised against misuse of military, security tools and human longevity etc., may lead to irreversible disasters in the society. We need to create a definite set of policies or guide lines that will aid in either eliminating or at least minimizing the detrimental effects raised due to the rapid implications of Nanoscience. Since nanotechnology is a convergence of various disciplines, bioethical laws alone may not be able to cope up or held responsible for resolving all the issues. This has necessitated to curtain rise a new branch of ethics, called as 'Nanoethics'. This nano ethical frame work considerably confluences all synergic ethical issues with various disciplines amalgamated in Nanoscience and technology. Unsurprisingly, stakeholders in India are using many nano products without bothering about the risks behind due to their easy accessibility and simplicity. Even government has not paid much attention until recent launching of Nano mission (2007) by Department of Science and Technology (DST). But still there are no definite set of policies formulated to maneuver the risk assess-

ment, management and communication in India. Nanoethical frame work needs to be strengthened further more, by clubbing all stake holders and experts to form permanent central co-ordinate bodies to guide, formulate unbiased policies and also to envision anticipated nano strategies for future implications and to face market challenges.

KEYWORDS: Nano pollution, Nanoethics, Risk assessment, Nano mission, Nanotechnology.

INTRODUCTION

Nanotechnology also referred to as Nanotechnoscience (Nordmann, 2004), a new and fast developing technology of Nanoscience taken afoot between 1990-2000 in India and enjoys major share of large influx of public funds. This technology involves the precise manipulation of materials at molecule level roughly ranging from 1-100 nm. At nano scale, quantum physics plays a dynamic role in behavior of materials and properties mainly governed by its large surface to volume ratio. Surprisingly, a drastic/clear change in physical and chemical properties change can be observed at nano scale level. For instance, at nano scale, materials which do not conduct electricity might become very good electrical conductors and the materials which are very brittle and inactive might acquire super strength and elevated catalytic activities. At nano level individual atoms are being manipulated which are building blocks of nature. Perhaps, no other branch of science had ever percolated into society commercially as nano technology. Due to its vast research scope & applications, though it has drawn its concepts from various disciplines it has raised up to a distinct discipline level. This technology has become more constructive to command/draw attention for research and also attract inflow of money for further expansion, virtually to create anything that we want in future.

New properties of nano materials have been exploited in various field to enable us to develop many products such as – smaller and faster processing chips to enable computers to be embedded in our clothing or even in our body, medical devices for less invasive surgeries, more targeted drug delivery, strong and light materials for safer and energy efficient transportation, many pollutant filters for ecofriendly environment, energy weapons, light armor for new military capabilities (Lin and Allhoff, 2007). Many nano technology products are entered into the market right from stain and scratch resistant paint to more effective cosmetics. Some of the major applications include water purification systems, energy systems, nano medicine, nutrition and large scale infrastructure auto fabrication (United States National Nanotechnology initiative, 2016).

Discoveries and innovations in nano science are occurring at breath taking pace especially in medical field. Almost making possible to target the malignant tissues for chemotherapy in cancer treatment (Kubile et al. 2005), nano particles to aid drug delivery and nano neuro surgery, nano rises for monitoring brain activities, nanofibre brain implies and nano scaffolds to repair neural issues (Jain, 2006) etc.

Some of the recent commercial nanotechnology products are Cerax nanowax for snow skis, Franz Ziener waterproof ski jacket (NanoTex), Wrinkle and stain resistant nano-care clothing, L'Oréal deep penetrating skin cream, Kodak's OLED (organic light emitting diodes) camera, Performance sun glassed nanofilm anti-reflective coating, Z-COTE sunscreen, Babolat nanotube tennis racket, InMat's nanotech tennis balls, Shockjock Aerogel footwarmers, Simmons washable bed mattress (NanoTex), Maruman & Co. golf clubs using 'titanium fullerenes', Nanodynamics golfballs, Bionova 'personalized skin care', Nucryst wound dressings for burn victims, coated with 'nanosilver', Envirosystems EcoTrue nanoemulsive 'military grade' disinfectant, BASF's Mincor superhydrophic spray for coating building materials to make them water-resistant, Nanofilm's ClarityDefender window spray, Flex Power joint and muscle pain cream (using'90 nm liposomes'), 3M dental adhesive (nanohydroxyapatite) etc **(**UNESCO 2006).

Does this technology cause nano Pollution / nano toxicity?

As nano materials are building blocks of nature, presence of these may not be hazardous as such. Certain aspects like translocation, bioaccumulation increased reactivity in bio-geo cycles, may be hazardous which is addressed as 'nano pollution'. Nano pollution is caused by two types of structures one is any device like nano composites, nano components (Electronic, optical sensors etc), and nano structure surfaces, where in nano particles are impregnated in the device and the second one are free nano particles of individual elements. The free nanoparticles may be simple compounds (passive nanostructures) or complex compounds (active nano structures) such as nano particles of a particular element coated with another substance (Core shell nano particles) (IRGC report 2007). Frees nano particles are of immediate concern, and also their agglomeration behaves different from individual nano particles. Nano toxicology accounts for potential health risks rose due to easy penetration of non-degradable or slowly degradable nano particles and their accumulation in phagocytes. These overload phagocytes may trigger stress reaction leading to inflammation in turn reduces defense

against other pathogens. They may also interact within regulatory mechanisms of enzymes and other proteins (Maynard et al, 2006).

Why to be so Panic?

In countries like India, Nanotechnology is being explored and mainly gained prominence to attract large influx of funds for research in order to address urgent societal basic needs like water purification, health care etc. The nano particles produced/used in different techniques may also differ in their reactivity. Bio-persistence, electrophilic, hydrophilic and phobic nature of these particles sometimes may raise undesirable effects, (Kjolberg and Nickson 2010) nevertheless, any new and revolutionary technology always come as a package with the promise of new opportunities and the threat of new risks (Azo nano 2008).

Though nanotechnology has revolutionarized in this third millennium to bring drastic changes to improve human lives, it is often referred to as 'Disruptive technology'. There is a schizophrenic afoot outside the industries, academia, among stake holders regarding technology and its implications which they are not aware of. There are more ethical issues to be worried about.

- What is the moral imperative behind manufacturing goods from inexpensive raw materials? (Does it increase toxicity levels, penetrate cell walls?).
- What is level of bio accumulation of nanoparticles to imbalance ecosystem? (Translocation in body and environment).
- What if Molecular manufacturing could spawn another dramatic shift akin to keep a lot of people out of work?
- What would motivate people to work hard if the molecular replication produces whatever people need?
- What if nano medicine cellular repair halt ageing processes?
- What about justice, intellectual properties rights, accountability and misuse of military and security nano devices?
- What is the responsibility of industries to build up safety suited designs for developed technologies?
- How about privacy issues like undetectable surveillance, Right to Privacy would be Jeopardized.

Do these come under the scope of bioethics?

All these issues cannot be completely taken by bio-ethics though they are concerned about human health and environment. The scope of bioethics can be expanded with various aspects of biotechnology like cloning, gene therapy, human genetic engineering, astro ethics and manipulation of basic biology through altered DNA, XNA and proteins etc (Mautner and Michael, 2009). All this technology is expanded rapidly beyond human imagination like science fiction. Though bioethical laws are struggling hard to do justice to some ethical issues but it is becoming impossible to address many. There should be special attention proactively drawn to address ethical, social, political, environmentally aspects of nano science and technology to minimize the adverse impacts on the environment and public health. Since nano technology is convergence of various disciplines, bioethical laws alone may not be able to cope up or held responsible for resolving all issues. This has necessitated to curtain rise a new branch of ethics, called as 'Nanoethics' to safe guard ethical issues related to nano technology.

Is Nanoethics a different discipline?

Nanoethics was raised as a discipline in 2007 in order to provide a forum for analyzing the specific difficulties raised by Nanotechnology (Vanessa Nurock, 2010). *Nanoethics* means something like the ethical, social, environmental, medical, political, economical, legal issues and so on, concerned with nanotechnology. There is lot of debate going on over Nanoethics for its unique issues of past technology apply to nano science (Godman M, 2008; Nordmann A & Rip A 2009).

The term *Nanoethics*, being criticized by many (Ferrari, 2010; Brownsword, 2009; McGinn, 2010) due to lack of novelty in ethical questions provoked by nano technology and the 'ethics of nano technology' has been shown as less unbiased alternative (Weil, 2003; Grunwald, 2010). The Ethical issues concerned with another technological context, not only anything at nano scope, but only regarding ethical issues concerned with nanotechnology comes under Nanoethics. This is often referred as ethics of nanotechnology. Best time for considering the ethics of nanotechnology is also under grate debate. Nanoethics, considerably confluences all synergic ethical issues associated with various disciplines amalgamated in nano science and technology. It is convergence of many ethical areas as well (Allhoff and Lin, 2006). Ethics of nanotechnology should definitely depict the development of trust building, public involvement, anticipation of objections and also guidance for responsible development of the technology (Nordmann and Rip, 2009) In the present scenario, Nanoethics is emphatically more

concerned with risk assessment, risk management, risk communication. Unsurprisingly in India, stakeholders are using many of the R & D nano products without bothering about risks behind them due to their easy accessibility and simplicity.

Perhaps, many times ethical and social issues (Questions) raised from nanotechnology would seem to be same kind of questions already rose in the other fields and may be some are unique. But still needs special attention as different discipline due to its rapid percolation in all fields including global security.

In a survey conducted by Debasmita Patra, 95% of the Indian practitioners who are involved in Nanoscience and nanotechnology research, have recognized the ethical issues in this area. Nano ethics will be possibly concerning various issues, majority fall into following 9 types (Debasmita et al 2010).

1. Possible ill effects of nano materials on environment and human health - both inside and outside the laboratory.
2. Use as a weapon – use of nano techno science for destructive purpose is unethical.
3. Hype – Too much exaggeration or hype about nano techno science like misguiding B.Tech graduates for job opportunities.
4. Professional ethics – Professional research inside the laboratory regarding reproducibility, repeatability and manipulation of results.
5. Laboratory testing on animals.
6. Cyborgs – incorporating gadgets to human body (Partly human and partly machine) and enhancing the capacity of human beings. This creates a gulf between people who have access to the technology and who do not have access.
7. Widening the gap between rich and poor – as anything to do with nanotechnology is expensive. This may bring asymmetry in our economic structure.
8. Self-replication – self replication of toxic nano particles spray in to atmosphere.
9. Longevity of human life – Societal, economical, political issues rose due to longevity of life by cellular repair and targeted drug delivery system.

What is the Emphatic status of Nanoethics in Risk governance in India

India started concentrating on research of high- priority fields of science and technology after launching IRHPA (Intensification of Research in High Priority Areas) in the sixth year plan (1980-85). Since then many potential areas of research had been intensified by involvement

of core scientific expertise, technological facilities nationally coordinated programmes in multi disciplinary areas (DST 2007). Though nanotechnology footed in 1980's, India could initiate its own programme only after launching Nano Science and Nanotechnology initiative (NSTI) in the year 2001. Since then Nanotechnological programmes are led by government programmes through Department of Science and Technology (DST), Department of Biotechnology (DBT), Department of Information Technology (DIT), Indian Council for Medical Research (ICMR), Department of Atomic energy (DAE), Defense Research and Developmental Organization (DRDO), general industries, research institutes and civil society through large influx of funds to develop nano products on par with international standards. But, the ethical issues were of no concern, completely neglected. Even government has not paid much attention until recent launching of Nano mission by Department of Science and Technology in the year 2007. DST is the nodal agency to launch Nano Mission to develop in the areas of national relevance like safe drinking water, sensor development, materials development, drug delivery etc. This mission mainly aimed to promote basic research, infrastructure development, human resource development and international collaborations in nano field and also to achieve synergy and forge linkages between education, research institutes & industries to promote public and private partnership.

Risk Governance and Regulations in nano field are the missing elements and have received nil or very less attention till recent days. Initially, DST acted as the ministry responsible of risk coverage and later ministry of environment and forest (MOEI) held responsible, but neither of them framed any policies as such to resolve ethical issues rose in nano research. It is not surprising then those products like silver nano washing machine and insecticides introduced into Indian marked without any risk analysis. It is a challenging task to regulate nano technology due to its intrinsic (Characteristics) multi-sectorial applications. The divergent risk issues raised or anticipated by utilization of nano technological process and production cannot be addressed by a single agency and under an exclusive regulatory frame work (Corley et al 2009-NT. Risk Govt. of India).

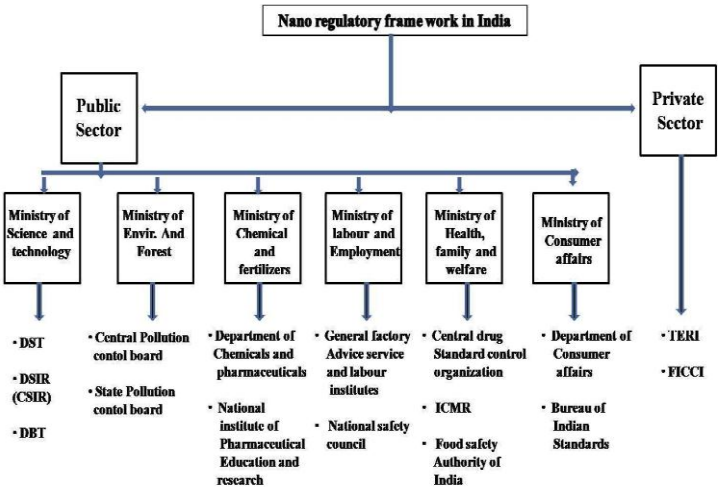

Fig 1: Regulatory frame work for nanotechnologies in India.

India has very loose frame work (Fig 1) to govern nanotechnological ethical issues and has no definite set of policies formulated to maneuver the risk assessment, risk management and risk communication (Jayanthi et al, 2012). In fact none of the legislative regulations framed to maneuver the ethical, health and environmental issues under pollution control, environmental protection, bio medical and hazardous waste disposal, safe manufacturing of drugs and occupational health and safety, have explicitly identified nanoparticles as a hazard. It is extremely difficult to deal with the ill effects of nanotechnology on health and environment with the currently available flexibility with in the legal regimes (TERI, 2010). Out of the three regulatory policies released by DST, policy 1983 was found to be better to safe gourd the issues.

Till now there is only one policy formulated in Nanoscience, by Insecticides (Amendment) Bill in December 2015 by Member of Parliament Sri. Keseneni Srinivas. This bill has been introduced to Lok Sabha to grant only a provisional registration to insecticides containing nanoparticles with a condition that "it shall be mandatory for the manufacturer or importer to report any adverse impact of the insecticide on humans and environment in a manner specified by the Registration Committee." This is an improvement over the earlier process of granting permanent registration to insecticides. In order to strengthen risk governance DST had released "Guidelines and best practices for safe handling of nano-materials in research laboratories and industries" manual for nanotechnological research and also concentrated to study the toxicity, environmental and health implications of nanomaterials (DST, 2010).

Due to uncertainty associated with this field, the present knowledge regarding social, economical, environment and human health is not sufficient to craft a frame which can cover all the facets of nanotechnology. Now Government of India also appointed a task force to advice Nano Mission Council to develop a regulatory body to safe guard Nanoethics. Nanoethical frame work needs to be strengthened further more, by clubbing all the stake holders and experts to form permanent central co-ordinate bodies to guide, formulate unbiased polices and also to envision anticipated nano strategies for future implications and to face market challenges.

CONCLUSION

After having completely realizing the potential benefits of nano science and technology, we cannot deny or stop further more exploration to develop more and more and also it is penetrated in different fields of research. However, in future scientists, experts, ethical agencies, research institutions should come forward honestly through multi stake holder engagement approach to frame and follow certain set of rules and guidelines to ensure more harmless technology for welfare of the society.

REFERENCES

1. About the National Nanotechnology initiative, United States National Nanotechnology initiative, Official web site: www.Nano.gov.com 2016.
2. Allhoff. F and Lin.P "What's So Special About Nanotechnology and Nanoethics?"*International Journal of Applied Philosophy*, 2.2, 2006; 20(2): 179–190.
3. Azonano.com: "India Announce Further Investments into Development of Nanotechnology", viewed on 9June2011(http:/www.azonano.com/news.aspx?newsID = 9199). 2008.
4. Brownsword R Nanoethics: old wine, new bottles? J Consum Policy 2009; 32: 355–379.
5. Corley, Elizabeth A, Dietram A Scheufele and Qian Hu *"*Of Risk and Regulations: How Leading US Nanoscientists form Policy Stances About Nanotechnology*", J Nanopart Res*, 2009; 11: 1575-85.
6. DST Technology Policy Statement 1983, viewed on 12 April 2011 (http://www.dst.gov.in/stsysindia/ sps1983.htm). 1983.
7. DST "Science and Technology Policy 2003", viewed on 12 April 2011 (http://www.dst.gov.in/stsysindia/stp2003.htm#c1)., 2003.
8. DST "*Nano Mission*", viewed on 11 April 2011 (http://nanomission.gov.in)., 2007.

9. Ferrari A Developments in the debate on nanoethics: traditional approaches and the need for a new kind of analysis. NanoEthics, 2010; 4: 27–52.
10. Godman M But is it unique to nanotechnology? Sci. Eng Ethics, 2008; 14: 391–403.
11. Grunwald A From speculative nanoethics to explorative philosophy of nanotechnology. Nano Ethics, 2010; 4: 91–101.
12. Guidelines and best practices for safe handling of nano-materials in research laboratories and industries mannual- DST- 2010.
13. Jain. K Role of nanotechnology in developing new therapies of the nervous system. Nanomedicine, 2006; 1.9-12.
14. Jayanthi. A.P, Koen beumer, Sujit bhattacharya Nanotechnology Risk governance in India. Economic & Political weekly., 2012; 4: 34-40.
15. Kjolberg, Kamilla Lein and Fern Wickson, ed. Social Perspectives on Nanoscale Science and Technologies (Singapore: Pans Standford Publishing)., 2010.
16. Kubik T, Bogunia-Kubuk K, Sugusaka M Nanotechnology on duty in medical applications. Curr.Prarm. Biotechnol., 2005; 6: 17-33.
17. Mautner and Michael, Life centered ethics and the human future in space. Bioethics., 2009; 23: 433-440.
18. Maynard AD, Aitken RJ, Butz T, Colvin V, Donaldson K, Oberdörster G, Philbert MA, Ryan J, Seaton A, Stone V, Tinkle SS, Tran L, Walker NJ, Warheit DB Safe handling of nanotechnology. Nature, 2006; 444: 267–269.
19. McGinn RE What's different, ethically, about nanotechnology?: Foundational questions and answers. Nano-Ethics, 2010; 4: 115–128.
20. Nanotechnology Risk Governance Guidelines issued by International Risk Governance Council, Geneva, 2007.
21. Nordmann A Molecular disjunctions: staking claims at the nanoscale. In: Baird D, Nordmann A, Schummer J(eds) Discovering the nanoscale. IOS Press, Amsterdam, 2004; 51–62.
22. Nordmann A, Rip A Mind the gap revisited. Nat. Nanotechnol, 2009; 4: 273–274.
23. Lin P. and Allhoff. F. "Nanoscience and Nanoethics: Defining the Disciplines", Nanoethics: The Ethical and Social Implications of Nanotechnology, Fritz Allhoff, Patrick Lin, James Moor, and John Weckert (eds.), Hoboken, NJ: Wiley, 2007; 3–16.
24. Patra, Debasmita, Haribabu Ejnavarzala and Prajit K Basu "Nanoscience and Nanotechnology: Ethical, Legal, Social and Environmental Issues", Current Science, 2009; 96: 653-55.

25. The Ethics and Politics of nanotechnology, UNESCO., 2006.
26. The Energy Resource Institute Regulatory Challenges Posed by Nanotechnology Developments in India, TERI, Delhi., 2010.
27. UNESCO *The Ethics and Politics of Nanotechnology*, UNESCO, France., 2006.
28. Vanessa Nurock. Nanoethics: Ethics For, From, or With Nanotechnologies? HYLE – International Journal for Philosophy of Chemistry, 2010; 16: 31-42.
29. Weil V Zeroing in on ethical issues in nanotechnology. Proc IEEE., 2009; 91(11): 1976–1979.