Developing a New Safety Program in Nanomaterials at a Cancer Research Facility

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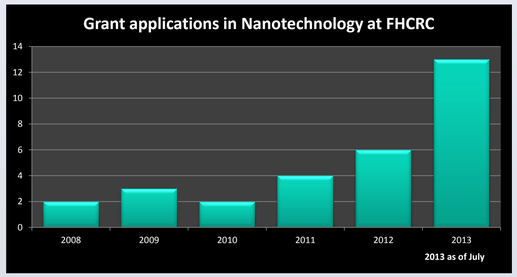
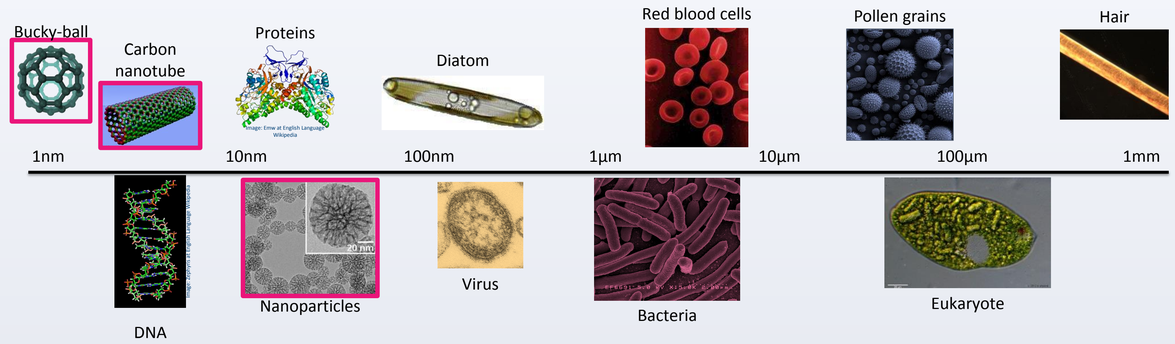
INTRODUCTION

Nanoparticles, particles of 100nm or less in one dimension, come in many different forms and can have many different modifications, coatings, and internal loads all of which present their own safety problems. Nanoparticles have been implicated in human, rodent and cell culture studies as a basis for concern for adverse health effects such as cancer or respiratory diseases [1]. Nanoparticles diminutive dimensions make inhalation, dermal absorption and ingestion routes of exposure a greater risk than larger particles of the same composition [1]. National Institute for Occupational Safety and Health (NIOSH) is compiling data and working in conjunction with subject matter experts to establish cause and effect of nanoparticles and build better safety guidelines. Currently general safety guidelines are established but more definitive guidelines are needed to guide EH&S professionals, primary investigators (PI's) and research laboratory staff.



Nanomaterials are increasingly used in cancer research as they are effective at reaching specific cancerous tissues and do less damage to healthy tissues than conventional treatments [2]. Research at Fred Hutchinson Cancer Research Center involves nanoparticles with biologically active substances conjugated to them for stimulating immune reactions or targeted delivery of cytotoxic drugs to cancerous cells. For this reason Biosafety is an integral aspect of working with nanoparticles. However, often the biological portion is the focus since there is little known yet on the long term effects of nanoparticles. Exposure to workers is threefold with nanoparticle work: biologics, chemical and the physical particle risks. Personal protective equipment (PPE) needed to safeguard workers for biological and chemical dangers may or may not be appropriate for the nanoparticle. At the Hutch grant applications using nanomaterials have more than doubled in a single year. This rise in new technology must be considered for risk analysis and the development of a nanoparticle safety program that will address risks of working with nanoparticles.



OBJECTIVES

RESULT/EXPECTED OUTCOME

Obtain Primary Investigator and Scientist current views on nanoparticles and their safety	PI's and Scientists were interviewed in labs that use nanoparticles. Currently, there are no guidelines for handling nanoparticles and practices are varied. "As with any new technology or new material, the earliest exposures will likely occur for those workers conducting discovery research in laboratories" [1]. Disposal methods are also arbitrary due to the many forms and coatings the nanomaterials use. A policy on handling guidelines, training, disposal, and exposure procedures would unify the handling and use of nanomaterials.
Determine risks	Risks are variable, dependent on type of nanoparticle used, whether its manufactured in the laboratory or bought, dry or in suspension. Risks which get more attention, such as biologic and chemical risks, will not always have the correct PPE for the characteristics of the nanoparticle that is being used. More consideration for nanoparticle risks should be taken in conjunction with biologic and chemical risks.
Develop program	A program was developed to mitigate risks. This program will define nanoparticles, responsibilities of those involved with particles, EH&S responsibilities, exposure assessments, spill procedures, disposal procedures, and exposure and first aid response.
Implement program	The plan is to send a copy to all PI's working with nanomaterials and get their input on the program, then ask for feedback. This will address the challenge of PI buy-in as they have a part in shaping the program. The program will then be put into place in the Safety Manual as well as online on our intranet for quick access.
On-going monitoring of personnel and nanomaterials use	Laboratories will be put on a schedule to be combined with their annual or semiannual biosafety audits. Any changes of nanomaterials or updates to protocols will be noted by the PI in an nanoparticle registration amendment (see Table 1).
Leave flexibility	As more knowledge and research is done, the risk mitigation measures may be revisited to increase or decrease exposure control methods.
Create registration	A registration document has been made (see Table 1). A risk assessment might be repeated based on this registration and if any new knowledge is revealed in this process. As more properties are identified about nanomaterials more or different registration information may be required.

TABLE 1: NANOPARTICLE REGISTRATION

NANOPARTICLE SMALLEST DIMENSION AND COMPOSITION	PARTICLE SURFACE REACTIVITY	AGGREGATION STATUS	BIOLOGICAL, CHEMICAL, AND/OR RADIOACTIVE?
TOXICOLOGY OR HEALTH DATA	**EASE OF AEROSOLIZATION**	**CONTAINMENT**	**OTHER SAFETY ISSUES**

CONCLUSIONS

Nanoparticles are revolutionizing modern drug delivery and cancer therapies. With this new technology it is essential we ensure safety of those who work with these materials. Our facility is just starting out in this relatively new field and grant applications are doubling. The goal is to establish a safety program to unify laboratory handling and safety of nanomaterials. Challenges that are being faced are scientist buy-in, PPE determinations, and treatment of nanoparticle waste including solvents, drugs, and biologics. Implementation and on-going monitoring are proceeding into this fall.

REFERENCES

1. **National Institute for Occupational Safety and Health.** *General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories.* s.l. : DHHS (NIOSH), May 2012.

2. *Effect of cationic side-chains on intracellular delivery and cytotoxicity of pH sensitive polymer-doxorubicin nanocarriers.* **Fang, Chen, et al., et al.** 2012, Nanoscale, pp. 7012-7020.

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