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Oral Medicine

Nanorobots -The New Champions in the Making!

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Review Article

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Abstract: Nanotechnology, has redefined the very concept of the medicine and dentistry by transforming mere pipe dreams to actual reality. As forecasted, it has revolutionized various scientific and technological fields by enabling the control over material properties at ultrafine scales. This review article focuses on nanorobots; their development, mechanism of action and applications and their various challenges in the field of medicine and dentistry.
Keywords: Nanorobots, nanotechnology, nanodentistry.

INTRODUCTION

''There's plenty of room at the bottom'' was the title of the path breaking lecture by Richard Feynman in 1959, that introduced the concept of nanotechnology, the focus for future scientific researches [1]. As predicted, nanotechnologies in general, and Nano robots in particular, have radically transformed the field of medicine, especially the concept of drug delivery systems. Nanotechnology is not just a mere shrinking of larger objects to the microscopic scale of a nanometer (10^{-9} meters) but also altering its physical and chemical properties accordingly[2,3].

Conceptual origins

Theoretically, nanorobots are microscopic devices which measure approximately a nanometer in dimension (1nm = 1 millionth of a millimeter). They are employed to work in both the medical and industrial fields at atomic, molecular and cellular levels, turning what seemed like fiction yesterday, into reality today[4-6].

Mechanism of action- How it works?

Nanorobots can be considered as the 'tailor-made mechanised version' of bacteria [7, 8]. They are designed to function like bacteria or any normal virus. These 'miracle particles' are composed of tiny silicon pieces called transducers and are powered by a battery or a tiny solar cell. These transducers utilize the energy generated by the robot's solar cell and convert it into mechanical power. The structural design of a nanorobot consists of an interior and exterior component. The external component is built to withstand exposure to various chemical fluids in the body. It comprises of carbon atoms forming a unique diamond structure which contributes to its enhanced strength and inert properties. In addition, its super smooth surfaces reduce the probability of triggering body's immune mechanism, thereby permitting nanorobots to work without any interference [7]. The internal component of a nanorobot is a confined vacuum type environment which doesn't permit external fluids to enter, unless required for chemical analysis.

The doctor's commands are encoded to acoustic signals at carrier wave frequencies (1-100 MHz), and are received via acoustic sensors attached to the surface of nanorobots. Once the commands are executed, nanorobots are easily disposed from the body to prevent further break down and malfunction.

Biomedical applications of Nanorobots – What to Expect?

Nano medicine [3,9]

- Early diagnosis and targeted drug-delivery for cancer, instrumentation, surgery, pharmacokinetics, and health care.
- Employing nanorobots to work at a cellular level by simply injecting them into the patient's bloodstream.
- Introduction of a plethora of advanced technologies that offer customized solutions to optimize delivery of pharmaceuticals.
- Assistance in the repair of tissue cells in conjunction with white blood cells.
- Application in diabetic patients, to control and monitor blood sugar levels.
- A remarkable tool in targeting and destroying kidney stones.
- A novel aid in the treatment of atherosclerosis

- Cryostasis- a terminally ill patient can be frozen and stored at the temperature of liquid nitrogen for an extended period, until medical expertise becomes sufficiently proficient to revive the patient's health. This application is still in the research phase.
- Gene therapy - genetic diseases can be treated by correcting or modifying any irregularities found, by the comparison of cellular DNA and protein molecular structures to known or desired reference templates.

Nano dentistry [10-12]

- In early disease identification or predisposition at cellular and molecular level.
- 'Needleless' delivery of local anaesthesia - done by instilling a colloidal suspension containing millions of active analgesic nanorobotic particles onto the patient's gingiva. These particles then reach the dentin by painless migration into the gingival sulcus via the lamina propria or the loose tissue at the cemento dentinal junction. From dentine they move towards the pulp by various processes such as chemical gradients, temperature variations and positional routing, directed by an onboard nanocomputer, controlled by the dentist.
- As dentifrices, by delivering them as mouthwash or toothpaste. They can act by metabolizing trapped organic matter into harmless and odourless vapours and performing continuous calculus debridement.
- In management of dentinal hyper sensitivity by using reconstructive dental nanorobots, with native biological materials, which can selectively and precisely occlude specific tubules within minutes, offering quick and permanent cure.
- In major tooth repair by manufacture and installation of biologically autologous whole replacement of tooth
- In restoration of teeth with nanostructured composite material, sapphire, which increases tooth durability and appearance
- In tooth renaturalization with native biological materials and helping in aesthetic restoration of decayed teeth.
- Application as highly developed Impression material- Nanofillers are integrated in vinylpolysiloxanes, producing impression materials with better flow, improved hydrophilic properties and enhanced detail and precision known as siloxane impression materials
- A viable option in maxillofacial injuries as bone replacement materials
- Nano needles incorporating nano-sized stainless steel crystals have been developed
- Nanoencapsulation can help in controlled drug release.
- Dentifrobots can identify and destroy pathogenic bacteria residing in the plaque, while allowing harmless oral micro flora to flourish in a healthy ecosystem. They also provide a continuous barrier to halitosis.
- Redefining contemporary orthodontic procedure by employing nanorobots that can directly manipulate the periodontal tissues thereby allowing rapid and painless tooth alignment, rotation and vertical tooth repositioning within minutes to hours when compared to the conventional techniques which takes months to years to complete.
- The success and longevity of dental implants can be improved several folds by the use of nano robots that can improve its surface characteristics.
- Helps in the early diagnosis of oral cancer by using various systems like nano electrical systems, oral fluid nano sensor test, optical nano biosensors etc
- The treatment of oral cancer is enhanced with the advent of advanced products like BrachySil(TM) and Hydrophobic porphyrins.

Challenges- The technical roadblocks

The most important challenge faced by this revolutionising technology is that, the funding for the research and development is not sufficient to cover the initial cost design which is very high. Though it sounds pretty simple on paper, the whole process is actually very complicated [14,15]. Electrical systems can create stray fields which may activate bioelectric-based molecular recognition systems inside the body. They are also susceptible to electrical interference from the outside environment. Nano robots may be misused by terrorists to destroy humans at molecular levels [12,13]. They can also be employed in spy networks, causing social challenges in ethics, public acceptance, regulation and human safety thus a major concern if fallen into wrong hands. Most importantly nanotechnology is a very recent discovery and is only just being put into use and its long term effects are yet to be known.

CONCLUSION

Nanorobotics has strong potential to transform the fate of contemporary healthcare and human life profoundly. Nanorobots hold a wealth of promise for future, from the timely detection to the cure of fatal diseases like cancer, HIV etc. This science which sounds more like fiction now can greatly improve the effectiveness, comfort and speed of future medical treatments and at the same time, significantly reduce their risk, cost, and invasiveness. They are thus, the new champions in the making.

REFERENCES

1. Ochekpe NA, Olorunfemi PO, Ngwuluka NC. Nanotechnology and drug delivery part 1: background and applications. Tropical Journal of Pharmaceutical Research. 2009;8(3).
2. Stylios GK, Giannoudis PV, Wan T. Applications of nanotechnologies in medical practice. Injury. 2005 Nov 1;36(4):S6-13.

3. Nanorobots are used in pharmaceutical sciences as a carrier. Ajay Kumar Pareek, Shiv Kumar Garg, Piush Sharma, Pramod Saini, Prateek Pitliy. Pharmanest International journal of advances in pharmaceutical sciences. 2013.
4. Nano dentistry. A paradigm shift from fiction to reality. Preeti Satheesh Kumar, Satheesh Kumar, Ravindra C Savadi, Jins John: J Indian Prosthodont Soc. Mar 2011; 11(1): 1–6.
5. Parveen RM, Harish BN, Parija SC. Emerging carbapenem resistance among nosocomial isolates of Klebsiella pneumoniae in South India. International Journal of Pharma and Biosciences. 2010;1(2).
6. Nan robots. Survey on Recent Developments in Medical Application. Sanchita Paul, Dipti; International journal of advanced research in computer research in computer science and software engineering. 2012; (2)4.
7. Dwivedi S, Dwivedi CD, Chandra A, Sharma N. Nanotechnology boon or bane for restorative dentistry; A review. International Journal of Engineering Science Invention. 2013;2:01-5.
8. Freitas RA. Current status of nanomedicine and medical nanorobotics. Journal of computational and theoretical nanoscience. 2005 Mar 1;2(1):1-25.
9. Cavalcanti A, Shirinzadeh B, Freitas Jr RA, Hogg T. Nanorobot architecture for medical target identification. Nanotechnology. 2007 Nov 29;19(1):015103.
10. Kukreja BJ, Dodwad V, Singh T. Robotic dentistry-The future is at the Horizon. Journal of Pharmaceutical and Biomedical Sciences (JPBMS). 2012;16(16).
11. Babel S, Mathur S. Nanorobotics-headway towards dentistry. Int J Res Sci Tech. 2011;1:1-9.
12. Gambhir RS, Sogi GM, Nirola A, Brar R, Sekhon T, Kakar H. Nanotechnology in dentistry: Current achievements and prospects. Journal of Orofacial Sciences. 2013 Jan 1;5(1):9.
13. Sahoo SK, Parveen S, Panda JJ. The present and future of nanotechnology in human health care. Nanomedicine: Nanotechnology, Biology and Medicine. 2007 Mar 1;3(1):20-31.
14. Drug delivery and nano particles. Applications and hazards. Wim H De Jong and Paul JA Borm. Int J Nanomedicine. Jun 2008; 3(2): 133–149
15. Nanomaterial health affects Part 3: Conclusion. Hazardous issues and precautionary principle. Marty S K. Wisconsin medical journal. 2007; (106)1.