Egyptian Journal of Bronchology

Vol. 6, No 2, December, 2012

CASE REPORT

THERAPEUTIC RIGID BRONCHOSCOPY ALLOWS WEANING AND EXTUBATION FROM MECHANICAL VENTILATION SECONDARY TO ACUTE RESPIRATORY FAILURE FROM CENTRAL AIRWAY OBSTRUCTION

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CASE REPORT

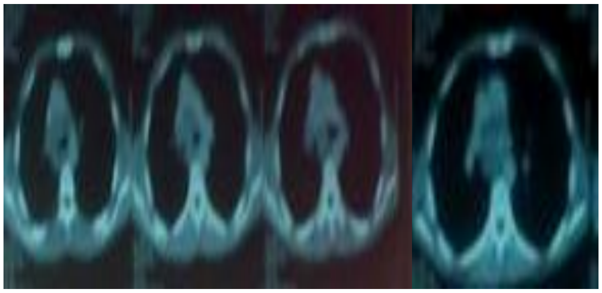
A 48 years old male Lorry driver with cigarette smoking history 70 packs / year and usual addiction history to cannabis, bango and tramadol was referred to Pulmonary Medicine Department Ain Shams University Hospital with progression of his shortness of breath since 2 week ago. The condition started 5 months ago by moderate exertion dyspnea, cough, expectoration of blood tinged greenish sputum and an attack of frank hemoptysis of about half cup that occurred once. The patient realized during this period loss of weight, loss of appetite and subjective fever. In last 2 weeks before referral the patient complained of progression of his dyspnea to be on minimal exertion. He sought medical advice at outpatient clinic were chest x-ray and CT scan chest were done and hence he was transferred to our department. On admission, his vital signs revealed a blood pressure of 120/80 mmHg, heart rate 90/min, temperature 37°C and respiratory rate 16 /min. Examination showed 1st degree clubbing, decreased movement and dullness over right (Rt.) inframammary and infrascapular areas with decreased intensity of harsh vesicular breathing over previously mentioned areas. Otherwise, no other clinical abnormality detected .

CT scan chest done 2 weeks before admission (Fig. 1) revealed multiple mediastinal lymph nodes enlargement (Rt. lower paratracheal & subcarinal) with concentric narrowing of Rt. main bronchus opening and right lower lobe posterior basal subsegmental consolidation.

Chest X-ray done on admission (Fig. 2) revealed picture of right lower lobe collapse (loss of lung volume over Rt. side, shift of mediastinum to Rt. side and elevated Rt. copula of diaphragm). All routine laboratory investigations were normal apart from elevated ESR 65 mm/second 1st hour and sinus tachycardia in ECG. An arterial blood gas on room air (RA) at admission was PH 7.41, PaCO2 33 mm Hg PaO2 71, HCO3 24.5 mEq/L SaO295 .%

Fiberoptic bronchoscopy (FOB) was arranged. The pre bronchoscopic oxygen saturation (SaO2) on RA was 94%. FOB was performed under topical anesthesia without any sort of sedation, continuous oxygen supplementation and pulse oxymetry monitoring. The FOB was terminated shortly after starting the examination because of significant persistent oxygen desaturation reaching up to SaO2 70% while the patient receiving high flow oxygen. Bronchoscopic examination revealed tumor mass infiltrating the Rt. lateral lower third of the trachea starting at 2 cm above the main carina and near totally occluding the entrance to the Rt. main bronchus. The main carina was infiltrated, but the left bronchial tree was normal with no apparent bronchial bleeding. Minimal amount of whitish bronchial secretions were aspirated from Lt. bronchial tree without taking any biopsy. Following termination of bronchoscopy SaO2 was on NP 6 L/min was 55% and local chest examination revealed no new findings. The patient was transferred to RICU and connected to high flow oxygen mask. ABG after 1 hour was PH 7.43, PaCO2 29 mm Hg PaO2 36, HCO3 21 mEq/L SaO2 70 %.

Then, the patient was connected to a non-rebreather mask at a rate of 15 L/min. ABG after 1 hour was PH 7.46, PaCO2 29 mm Hg PaO2 44, HCO3 21 mEq/L SaO2 81 %. At that time, the patient suffered from tachypnea while there was no cough, expectoration nor hemoptysis. Local chest examination revealed decrease intensity of breath sounds all over the Rt. Hemithorax.



(A)

(B)

(C)

Fig 1. CT scan chest 2 weeks before admission.

(A) Multiple mediastinal lymph nodes enlargement. (B) Concentric narrowing of Rt. main bronchus opening. (C) Rt. lower lobe posterior basal subsegmental consolidation.

Fig 2. Chest x-ray on admission

Chest X-ray was done (Figure 3) should progression of Rt. lung collapse reaching to near total collapse. Elective mechanical ventilation (MV) was done because the patient should signs of respiratory distress, exhaustion and persistent hypoxemia in spite of high flow oxygen on non-rebreather mask for more than 3 hours. Shortly, after MV the patient developed one attack of frank hemoptysis of about 50cc. At that time, the blood pressure was 80/60 mmHg.

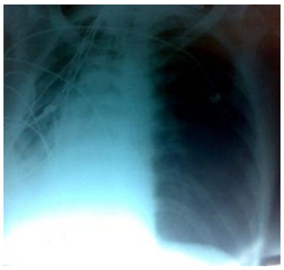


Fig 3. Chest x-ray after initial FOB

and his ABG on MV with tidal volume 420 L/min, respiratory rate 14bpm and FIO2 100% was PH 7.39, PaCO2 37 mm Hg PaO2 61, HCO3 23 mEq/L SaO2 92%. Rigid bronchoscopy was decided, but the anesthesiologist refused due to unstable blood pressure, oxygenation and need for 2 units of whole blood which was not available at that time. Central line was inserted and adjusted fluid therapy was applied. Beside portable FOB was done aiming to remove any secretions or blood clots in Lt. bronchial tree in order to improve patient oxygenation. FOB examination through endotracheal tube showed blood clots partially obstructing middle 1/3 of trachea, bloody secretions present all over subsegmental bronchi on Lt. side with spilling of blood over the Lt side bronchial tree from tumor mass obstructing Rt. main bronchus. Repeated suction and bronchoscopic toilet followed by topical application of Adrenalin and Tranexamic acid followed by patency of Lt. bronchial tree bronchi and hemostasis of bleeding. After 4 hours following FOB the SaO2 was 97% on FIO2 50% and blood pressure was 100/60.

Twenty four hours later, after stabilization of patient condition rigid bronchoscopy was performed (Figure 4). Electrocautery coagulation and tumor vaporization was done followed by dilatation and tumor debulking using mechanical resection of the tumor by the bevel of the rigid bronchoscope and repeated removal of resected tissues by the biopsy forceps and suction. Partial patency of Rt. main bronchus and bronchus intermedius was achieved. The rigid metallic suction probe could be introduced freely in Rt. lower lobe were abundant thick purulent secretions were suctioned. The Rt. upper lobe bronchus was completely occluded by the tumor. Biopsy was taken and was sent for histopathological examination. Corticosteroids and ventilatory support were provided. Gradual weaning and successful extubation was done over next 24 hours until patient reached to SaO2 was 98% on room air. His chest radiograph showed improved aeration with re-expansion of significant portion of the atelectasis Rt. lung. Biopsy result showed infiltrating adenocarcinoma. The patient was transferred to the oncology department for further management.

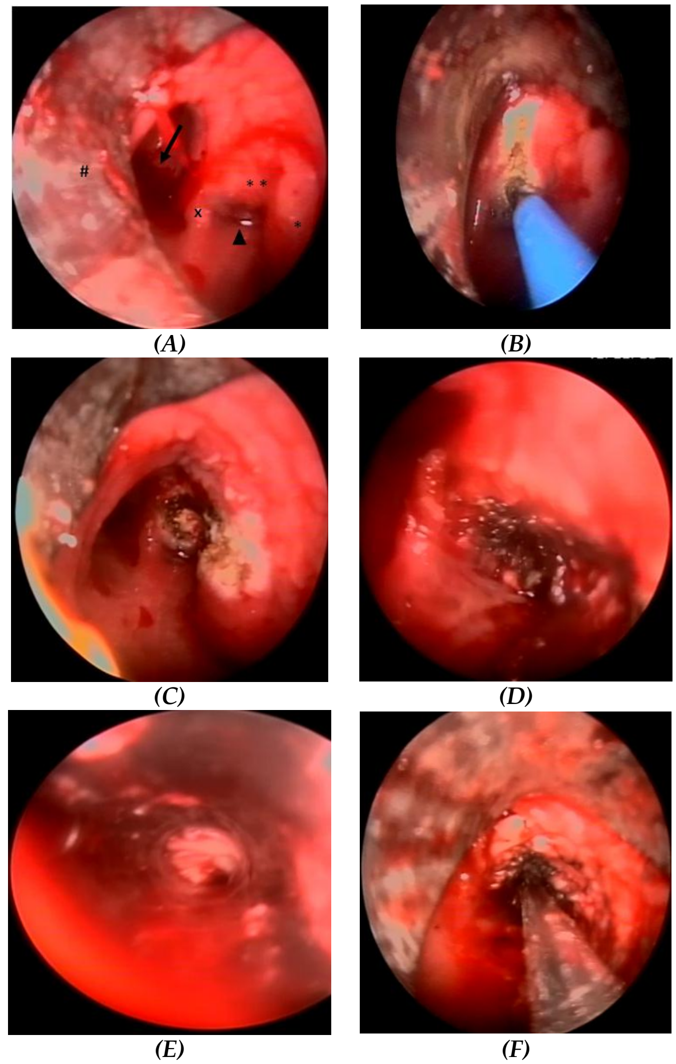


Fig 4. Serial rigid bronchoscopic findings and interventions of malignant central airway obstruction

(A) Immediately after rigid bronchoscope (RB) introduction showing the following: bevel of the RB (#), tumor (TU) mass at the Rt. lateral lower trachea (*), TU near totally occluding the entrance to the Rt. main bronchus (RMB) (**), trickling of blood form slit like opening of RMB (►), spill over blood occluding Lt. main bronchus opening (→) and main carina (x) infiltrated by TU. (B) Electrocautery probe shooting TU. (C) Electrocautery coagulation & TU vaporization.

(D) Partial debulking of TU in RMB (E) RB introduced in bronchus intermedius with TU remnants anteriorly. (F) Metallic rigid suction probe introduced distally in Rt. lower lobe bronchus

Comment:

Central airway obstruction (CAO) by malignant tumors is rarely life threatening, but can result in significant morbidity. The clinical manifestation of airway obstruction will not depend on underlying disease, but also on the site, severity and rate of progression in airway obstruction as well as the patient underlying health state in particular the available respiratory reserve.(1)

Bronchoscopy either rigid or flexible is always necessary in assessing CAO, allowing tissue diagnosis and the rigid bronchoscope (RB) is very helpful tool in emergency situation. However, performing bronchoscopy in patient with moderate to severe airway obstruction can act as a double-edged sword. Bronchoscopy may further precipitate the obstruction, making the patient hypoxic. RB helps in providing secure airway, excellent control of oxygenation and ventilation as well as relieving intraluminal obstruction by debulking the lesion. Flexible bronchoscopy (FB) may be difficult and potentially dangerous when obstruction is severe as the instrument will further obstruct the remaining lumen and does not allow for ventilatory support. Access to team equipped and experienced for advanced airway management along with equipments for emergency airway control is essential when undertaking bronchoscopy in these patients.(1-3)

Rigid therapeutic intervention is increasingly accepted to treat patient with CAO. Successful bronchoscopic intervention restores central airway patency and provides symptomatic and functional improvement. RB allows coring out of obstructing tumor; dilatation of tracheobronchial stenosis with barrel of the bronchoscope and therapeutic interventions such as laser, electrocautery and stent placement.(1,3)

Death from hemoptysis is rarely caused by exsanguination, but rather asphyxia resulting from flooding of the airways and alveoli with blood. In intubated patients, FB is the preferred initial procedure to localize the bleeding accurately to a specific bronchopulmonary segment or endobronchial site. In addition, FB can be performed at the patient's bedside. FB stabilizes the patient for subsequent definitive endobronchial therapy. FB may be useful in topical haemostatic measures applications as iced-saline lavage, topical saline/epinephrine solution and procoagulant substances e.g. topical Tranexamic acid application.(4,5) Repeated FB within installation of cold epinephrine saline in intubated patient with life threatening hemoptysis was successful in 6 out of 7 patients.6 RB obviously provides better scope for suctioning and allow application other modalities to stop bleeding as laser, electrocautery or cryotherpay. FB and RB can be used in conjunction with one another by passing the FB through rigid instrument.1 The ND-Yag laser or electrocautery used bronchoscopically can effectively stop bleeding from endobronchial pathology and can also allow more definite therapy at the same setting.(3) The situation of the patients, instruments available and bronchoscopists' expertise determines the choice of bronchoscopy and the method of immediate management of these patients .

Emergency rigid bronchoscopic intervention including tumor debulking using mechanical resection and electrocautery resection immediately affected the need for continued mechanical ventilation or intensive care level of support in critically ill patients with acute respiratory failure from malignant or benign CAO.(7)

In conclusion, emergency interventional bronchoscopy can favorably affect health-care utilization in patients with acute respiratory distress from central CAO. Treatment may be lifesaving and allows successful withdrawal from mechanical ventilation, hospitalization in a lower level of care environment, relief of symptoms, and extended survival in critically ill patients. In patients with regionally advanced cancer, the palliative nature of this procedure postpones death by respiratory distress and may prompt consideration for institution of conservative comfort measures to reduce patient suffering.(7)

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Egyptian Journal of Bronchology

Vol. 6, No 2, December, 2012

REVIEW ARTICLE

NANOTECHNOLOGY
"EMERGING MEDICAL MERICLES ON THE HORIZON"

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INTRODUCTION

Medicine is going through a period of great change. Researchers and scientists alike are constantly searching for new methods to improve the current medical system to offer patients better care, and to improve the efficiency of care delivery by physicians. One of the emerging promising advancements in the horizon is Nanotechnology. It is claimed that it is capable to produce a great jump in all medical practices.

But first; it is important – as physicians – to know exactly what nanotechnology means? and how to use it in medicine?

It is a quite interesting voyage, please hold your breathe, set your belts and get ready to start!

The beginning; definition of NanoTechnology:

It is the art and science of manipulating and rearranging individual atoms and molecules to produce useful materials, devices and systems.

Thus; extremely precised materials can be made, close to perfection to the point that exact number of atoms can be measured.

NanoMedicine: is the science of nanotechnology breakthrough implications in medicine. It is an interdisciplinary field of science; even simple project needs contributions from physicists, engineers, material chemists, biologists and end users - us - the physicians.

What makes NanoTech. unique?

It literally allows scientists and industry to build entirely new materials or machines that we may have only imagined in the past….

We can now really think outside the box!

Dream and hope; the sky is now our ceiling!

THE STORY

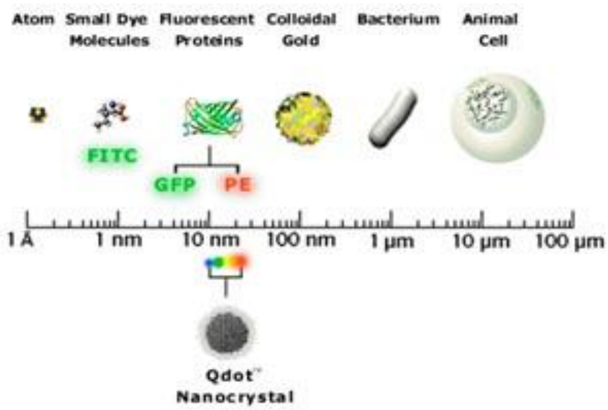
The concept of nanotechnology was first mentioned by Nobel Laureate Richard Feynman in his famous 1959 "nanotechnology" lecture, entitled: "There is Plenty of Room at the Bottom". He proposed that atom-by-atom assembly of materials might someday be possible.

Few years later at 1966; science fiction movie written by Isaac Asimov; entitled "The fantastic Voyage" assembled Feynman dream in medical practice. He imagined that tiny programmed personnel could be injected inside human body to perform highly specific jobs. This was the dream of what is called later; nanoRobots.

Nowadays; some nanoMedicine techniques are actually being used today, others are at various stages of testing, while others are still only imagined.

What is NanoScience?

The prefix "nano" is a Greek word for "dwarf". One nanometer (nm) is equal to one-billionth of a meter (meter = 109 nm). Red blood cell is 7000 nm wide. Atoms are smaller than 1 nanometer.



Nanoscale Size Effect:

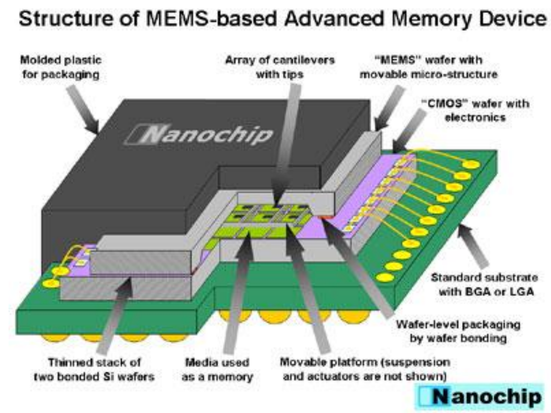
- Miniaturized devices and systems to provide novel/better functions.
- Attainment of high surface area to volume ratio.
- Manifestation of novel phenomena and properties, including changes in:
  - o Physical Properties (e.g. melting point)
  - o Chemical Properties (e.g. reactivity)
  - o Electrical Properties (e.g. conductivity)
  - o Mechanical Properties (e.g. strength)
  - o Optical Properties (e.g. light emission)

NanoScale Materials (Nanoparticles):

- They are materials which have feature size less than 100nm.
- They are utilized in nanoscale structures, devices and systems.
- They include; nanowires, nanotubes and bionanomaterials (either; natural or synthetic).

NanoScale devices and integrated Nanosystems

They include; Nanochips (Microelectromechanical System – MEMS), Nanoelectromechanical System (NEMS) sensors, Nanophotonic systems, Fuel cells, Lab on chip, Drug delivery systems and finally the most recent; Nanobots or NanoRobots.



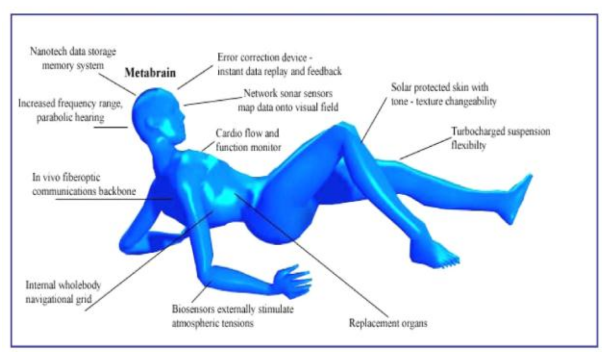
Examples of Nanotechnology Applications:

- Information technology; smaller, faster, more energy efficient and powerful computing and other IT based systems.
- Energy; more efficient and cost effective technologies for energy production (e.g. solar cells, fuel cells, battaries, biofuels, ….)
- Consumer goods;
  - o Foods and beverages; advanced packaging materials, sensors/nanochips for food quality testing.
  - o Textiles; stain proof, water proof and wrinkle free textiles.
  - o Household and cosmetics; self-cleaning and scratch free products, paints, and better cosmetics.

Applications of Nanotechnology in Medicine "NanoMedicine":

The dream; "Augmentation of the Human Body"

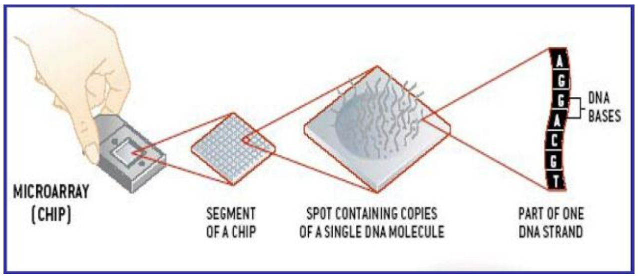
NanoMedicine can re-engineer the human body, including improvement of all the existing natural systems and addition of new systems and capabilities not found in nature.



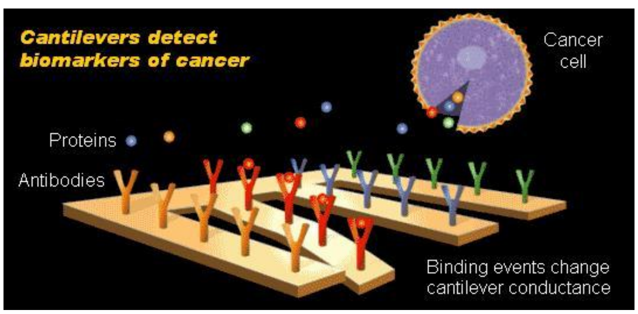
However; this dream still needs to be authorized by safety, environmental and ethical issues, it is not reached yet. But nanoMedicine shows now an extraordinary promising impact in both diagnosis & treatment of many diseases.

First: Diagnostic Applications of NanoMedicine

- Improved imaging of the human (or any) body
- Biosensors, Quantum dots and Lab on chips (Nano-tracking may be able to detect tumors very early)
- Microscopic sampling
- Microarray chips (proteins, DNA)
- Detection of airway abnormalities (even very distal) without invasive techniques



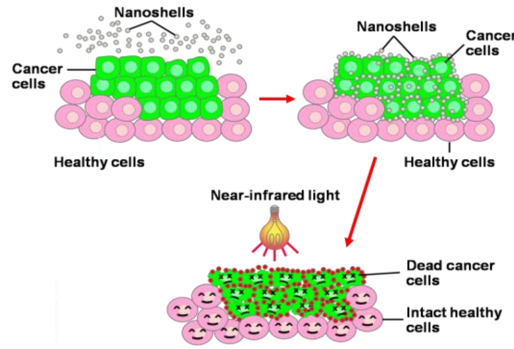
Microarry with single-stranded DNA



Lab on chips helps in early detection of cancer biomarkers

Second: Therapeutic Applications of NanoMedicine

- Delivering medication to the exact location (watering flowers without flooding the neighborhood - Nanotech is capable of delivering medication to the exact location where they are needed – hence lesser side effects).
- Killing of bacteria, viruses and cancer cells specifically without normal cell injury.
- Repair of damaged tissues.
- Oxygen transport.
- Skin and dental care.
- Augmentation of immune system.
- Treatment of atherosclerosis.
- Clottocyte hemostasis (stoppage of bleeding).
- Brain enhancement (treatment of Alzheimer).



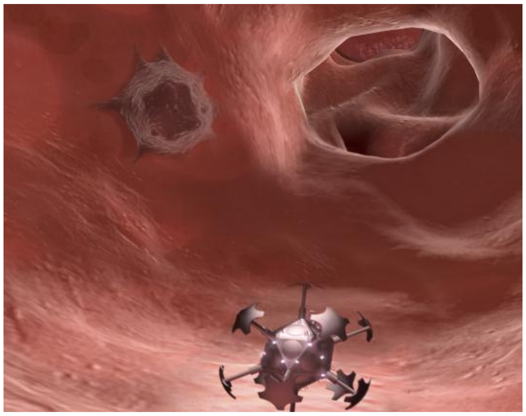
Thermal ablation (photosensitization) of cancer cells using Gold Nanoshells selectively attracted to cancer shells

Nanorobots: Medicine of the future!

What are they?

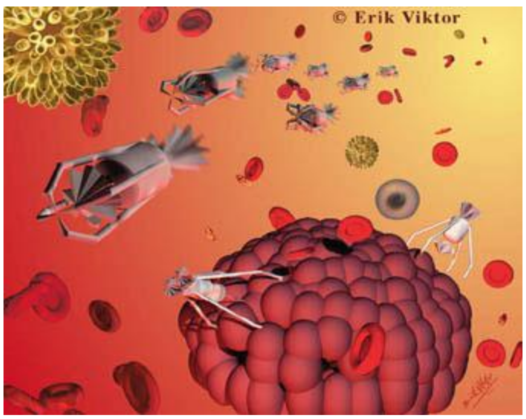
- Nanorobots are nanodevices that will be used for the purpose of maintaining and protecting the human body against pathogens.
- They will have a diameter of about 0.5 to 3 microns and will be constructed out of parts with dimensions in the range of 1 to 100 nanometers.
- The powering of the nanorobots can be done by metabolizing local glucose and oxygen for energy.
- They will have simple onboard computers capable of performing around 1000 or fewer computations per second.
- A navigational network (Map) may be installed in the body, which may provide high positional accuracy to all passing nanorobots.
- When the task of the nanorobots is accomplished, they can be retrieved by allowing them to exfuse themselves via the usual human excretory channels.

Examples of NanoRobots

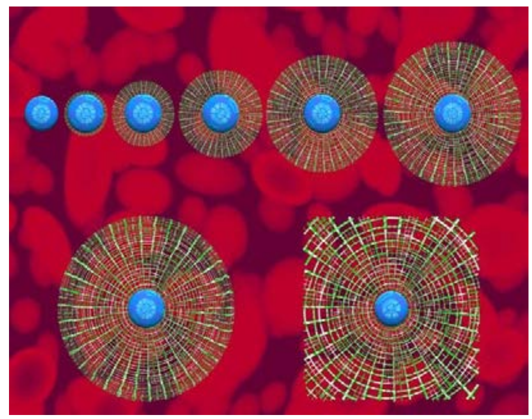


Airway Detector

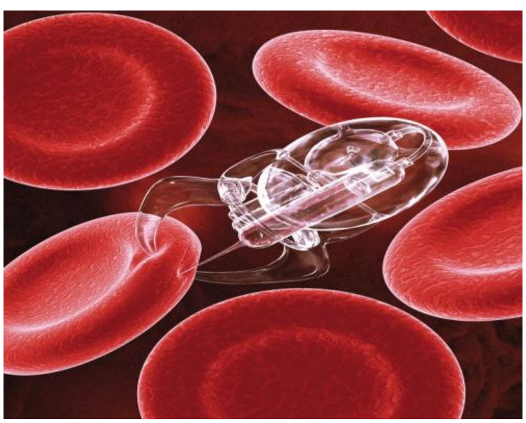
Virus Finder



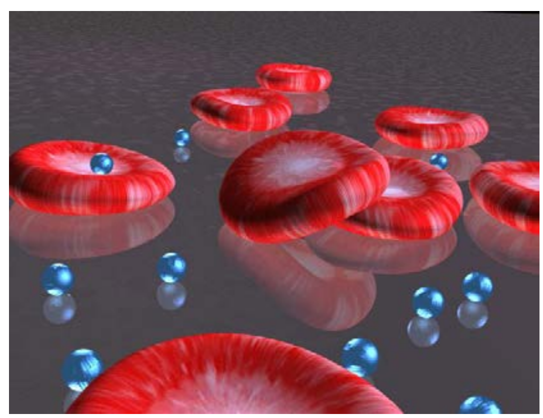
Programmed Tumor cell killer



Clottocyte



Pharmacytes



Respirocyte

Predicted Problems with NanoMedicine Applications:

1. Applicability; to induce effect over millions of body cells and cost of such highly complicated technology.

2. Safety; it is still questionable, autonomous nanorobots may be able to multiply without control.

3. Environmental issues; what if the human body becomes unbreakable, would the natural environmental balance persist?

4. Finally; ethical issues; the most important feature of nanotechnology is that it gives us control over individual molecules. Every patho-physiological process has a molecular origin, and the question arises, *Who is in control*?

Nanotechnology introduces things that are not natural or foreseen, such as genetically modified organisms. At this point there is no established system to regulate nanotechnology and there is no specific entity to control it. With the ability to identify and manipulate specific genetic sequences, people will seek the effects of good genes. People are already using this technology to modify their unborn children to have the right hair or eye color. In doing this people risk losing their individuality.

No doubt the benefits of this technology are innumerable but before taking any step we should think about the implications and the focus should be on developing a safe nanotechnology industry.

CONCLUSION

Nanotechnology is still in its early stages. The applications discussed in this report; some are actually being used today, others are at various stages of testing, while others are only imagined. As further research continues in this field, more treatments will be discovered. Many diseases that do not have cures today may be cured by nanotechnology in the future. Some of the concerns were also discussed but with proper care these problems can be avoided. Scientists who are against the use of nanotechnology also agree that advancement in nanotechnology should continue because this field promises great benefits, but testing should be carried out to ensure the safety of the people. If everything runs smoothly, nanotechnology will one day become part of our everyday life and will help save many lives.

Watch out! The dream is coming true.

25 WAYS NANOTECHNOLOGY IS REVOLUTIONIZING MEDICINE

1. **Nanorobots**: These devices have great potential for medical uses. These smallest of robots could be used to perform a number of functions inside the body, and out. They could even be programmed to build other nanorobots, increasing cost efficiency.

2. **Nanocomputers**: In order to direct nanobots in their work, special computers will need to be built. Efforts to create nanocomputers, as well as the movement toward quantum computing, are likely to continue to provide new processes and possibilities for the science of medicine.

3. **Cell repair**: Damage to the cells of the body can be very difficult to repair. Cells are so incredibly small. But nanotechnology could provide a way to get around this. Small nanorobots or other devices could be used to manipulate molecules and atoms on an individual level, repairing cells.

4. **Cancer treatment**: There are hopes that the use of nanotechnology could help in cancer treatment. This is because the small, specialized functions of some nano devices could be directed more precisely at cancer cells. Current technology damages the healthy cells surrounding cancer cells, as well as destroying the undesirables. With nanotechnology, it is possible that cancer cells could be targeted and destroyed with almost no damage to surrounding healthy tissue.

5. **Aging**: Nano devices could be used to erase some of the signs of aging. Already, laser technology can reduce the appearance of age lines, spots and wrinkles. With the help of powerful nanotechnology, it is possible that these signs could be done away with completely.

6. **Heart disease**: There is a possibility that nanobots could perform a number of heart related functions in the body. The repair of damaged heart tissue is only one possibility. Another option is to use nano devices to clean out arteries, helping unclog those that have buildup due to cholesterol and other problems.

7. **Implanting devices**: Instead of implanting devices as we have seen in some cases, it might be possible to send a nanobot to build the necessary structures inside the body.

8. **Virtual reality**: Doctors could explore the body more readily with the help of a nanobot injection. Creating a virtual reality that would help medical professionals and others learn could help make some operations more "real" and provide practice ahead of time.

9. **Gene therapy**: Nanotechnology would be small enough to enter the body and even redesign the genome. This would be a way to alter a number of conditions and diseases. However, the human genome would need to be understood a little better for truly advanced gene therapy. However, nanobots would be qualified for swapping abnormal genes with normal genes and performing other functions.

10. **Drug delivery**: Systems that automate drug delivery can help increase the consistency associated with providing medication to those who need it. Drug delivery systems can be regulated using nanotechnology to ensure that certain types of medications are released at the proper time, and without the human error that comes with forgetting to take something.

11. **Nanotweezers**: These devices are designed to manipulate nanostructures. These can be used to move nano devices around in the body, or position them prior to insertion. Nanotweezers are usually constructed using nanotubes.

12. **Stem cells**: Nanotechnology can actually help adult stem cells morph into the types of cells that are actually needed. Studies showing how nanotubes can help adult stem cells turn into function neurons in brain damaged rats.

13. **Bone repair**: It is possible to accelerate bone repair using nanotechnology. Nanoparticles made up of different chemical compositions can help knit bones back together, and can even help in some cases of spinal cord injury.

14. **Imaging**: Nanotechnology can provide advancements in medical imaging by allowing a very specific and intimate peek into the body. Nano devices result in molecular imaging that can lead to better diagnosis of a variety of diseases and conditions.

15. **Diabetes**: Instead of having to draw blood to test blood sugar level, nanotechnology is providing a way for diabetics to use lenses to check their blood sugar. These nanocomposite contact lenses actually change color to indicate blood sugar level.

16. **Surgery**: We already have robotic surgeons in some cases, but nanosurgery is possible using some lasers, as well as nano devices that can be programmed to perform some surgical functions. Being able to perform surgery at the smallest level can have a number of benefits for long term medicine.

17. **Seizures**: There are nanochips being developed to help control seizures. These chips are meant to analyze brain signals, and then do what is needed to adjust the brain so that epilepsy could be better controlled.

18. **Sensory feedback**: For those who have lost feeling in their body, it is possible to use nanotechnology to increase sensory feedback. Nanochips provide the opportunity for electrical impulses to be intercepted and interpreted.

19. **Limb control**: Prosthetics continue to advance, and nanotechnology is likely to help revolutionize the way paralysis is handled. There are some attempts to use nanochips that can help those who have lost limb control use their minds to send signals to provide a certain amount of motion.

20. **Medical monitoring**: You might be able to increase your ability to monitor your own body systems with the help of nanotechnology. Small nanochips implanted in your body could monitor your health and systems, and then send you feedback to your computer or other device.

21. **Medical records**: In addition to monitoring your own body systems, nanotech can be used to send information to your health care providers, and increase the efficiency of electronic medical records.

22. **Disease prevention**: Having a nano device in your body could actually help prevent diseases. With proper programming, it should be possible to help you avoid some diseases, repairing problems before they become serious issues. They may even be able to help prevent chronic diseases.

23. **Prenatal**: There are a number of ways that nanotechnology can help in terms of prenatal diagnosis. Being able to get inside the uterus and even inside the fetus without causing trauma can be beneficial to prenatal health, and nanotechnology can also help potentially repair problems in the womb.

24. **Individual medicine**: Nanotechnology is moving toward making medicine more personal. Being able to accurately work up your genome can help health providers more precisely pinpoint the proper treatments and tweak a treatment plan according to your individual needs and responses.

25. **Research**: Nanotechnology is advancing medical research, providing the tools that can help us learn more about the body and how it functions, as well as providing insight into chemistry and physics, which provide the building blocks for the body.

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