EDITORIAL OPEN ACCESS

Is nanomedicine just a fad or is it a necessary approach to improving medical technologies?

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The word 'Nanomedicine' is so popular that could be considered as the synonym of the word 'Medicine'. As proof, if one looks for the word 'Nanomedicine' using, Google search engine one is provided with 32 pages of resources consisting of 32 different topics. That is close to the 38 pages of resources provided by Google when one searches the word 'Medicine'.

Using Web of Science statistics the number of publications dealing with nanomedicince (search for the word "Nanomed") increased by 26 times between 2007 and 2009. The citations increased by 1200 times in between 2009 and 2014.

Is this just a fad or is there some other explanation for this explosion?

Let us have look at the Hippocratic Oath "With regard to healing the sick. I will take care that they suffer no hurt or damage" [1]. Following this precept one, can assume that both diagnostics and the treatment of the patient should be provided by the technique or method that interferes with the patient to at least extent. Non-invasive procedures definitely meet these criteria. The instruments employed should influence only the targeted biomolecules and are therefore characterized as having the same dimensions as the biomolecule, i.e., nm. This has caused nanodimensional medicine to be challenged for a long-time since industrial capacities were undeveloped and not ready for nanotechnologies. The ability to exploit them did not come until the end of 20th century and beginning of 21st century.

For instance, devices of the molecular size have only been available since around 2004 (Moore's law) [2]. This provided the conditions necessary for the leap from macro or micro medicine to the nano level. In fact, the National Cancer Institute (USA) for the first time launched the Alliance for Nanotechnology in Cancer in 2004 [3].

Therefore, one could conclude that Nanomedicine is the necessary and technologically available approach.

There are several definitions of nanomedicine.

Nanomedicine is:

"...the medical application of nanotechnology..." "...ranges from the medical applications of nanomaterials and biological devices, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology such as biological machines" [4].

"the application of nanotechnology to medicine and healthcare. The field takes advantage of the physical, chemical and biological properties of materials at the nanometer scale to be used for diagnosis, treatment and follow-up of diseases" [5].

"the application of nanotechnology to achieve innovation in healthcare" [6], etc.

Summarizing, the nanomedicine is the medical applications of the achievements of nanotechnologies. The latter are aimed at the "manipulation of matter on an atomic, molecular, and supramolecular scale" [7]. To get deeper understanding of the "manipulation of matter" let us use a quote from the speech of Nobel prize winner (1965) Richard P. Feynman at the American Physical Society annual meeting in 1959 where he used the term "building nanoobjects atom by atom or molecule by molecule" [8]. To make nanoobjects available to medicine one needs to manipulate them and assemble and control nanodevices as well as to deliver nanoobjects/nanodevices to/into the cell of the human organism. Therefore, nanomedicine can be characterized as the building of nanoobjects/nanodevices and manipulation within the human organism.

Physical and biochemical properties of the nanoobjects definitely depend on peculiarities, configurations, and quantity of atoms and molecules that are in use for building, the shape of the nanoobject contributing its properties, too. These are the ways to engineer mechanical, electrical, chemical, adhesive etc. modalities of the nanoobjects. However, the quantity of the atoms

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assembled within the nanoobject is significantly less that at the macro-object. Typically, the nanoobjects are scaled at ~ 100 nm.

The nanoobjects are classified as:

- Nanoparticles/dots (zero dimension object that is sized in any direction to ≈100 nm)
- Nanowires/tubes (first dimension object, sized in one direction to ≈> 100 nm)
- Nanofilms (second dimension object, sized in two directions to ≈ > 100 nm).

All of the above are employed by medicine (refer, for instance to [9]) for diagnostics and treatment. For example:

- nanoparticles are in use as drug, contrast agents, specific markers, drug delivery carriers, the sorption centers in photodynamic and hyperthermia therapy, etc .;
- the nanotubes are exploited for drug delivery, tissue regeneration etc.;
- nanofilms are employed for surface plasmon resonance analyses to identify proteins adhesion, coating of bioimplants, etc.

Interaction with the environment of any object is supplied via its surface (S). The effectiveness of the object-environment interaction could be indicated as the ratio S/V, where V is the volume of the object. If the latter has the spherical shape with the radius R ,

$$\frac{S}{V} = \frac{4\pi R^2}{4/3\pi R^3} = \frac{3}{R}.$$

In this connection, the effectiveness of the nanoparticles, that are characterized with R→0, to interact with the environment, is very high.

The nanoparticles have a great capacity to penetrate the cell membrane because of their small sizes. This is in useful in delivering drugs connected to the particles, modulate features of the cells, kill cancer cells, etc. The nanoparticles influence biological mechanisms within the human body. For instance, they interact with DNA, proteins, etc. The surface of the particle is often functionalized chemically of physically to engineer interaction with the cells and biomolecules.

The unique capacity of the nanoparticles to interact with the biological structures which rises the problem of nanotoxicity. This is particularly important when the nanoparticles are being widely used by the general public (washing liquids that contain nanoparticles, etc). It is therefore important that the consumer strictly follows safety instructions.

The gate to the nanoworld has been flung wide open! Nanotechnologies are developing at such rapid pace that the general public (sometimes scientists, too) is often unable to keep up with the technological progress in order to take full advantage of its benefits in both an effective and safe manner. The mission of this journal is to keep the general and scientific public informed of the nanotechnological developments as they apply to medicine and human health.

Keywords: Nanomedicine, Nanotechnology, Nanoobjects

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