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Editorial

Nanotechnology, Nanomedicine and Effective Disease-Targeted Medicines

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The potential and merits of "nanomedicine" is being mentioned in many publications; however, it appears that as yet an internationally accepted definition of nanomedicine has not been agreed upon [1]. Nanomedicine has developed from nanotechnology which is broadly defined as a way of creating and using materials at the level of molecules and atoms (sometimes but not always specified as being less than 100 nm). The focus of nanomedicine has been stated further as relying on "nano-interactions within a framework of a larger device or biologically with a sub-cellular (or cellular) system" [2]. Seems a bit vague to you? It does to me. Definition offered by the US National Institutes of Health defines [3] nanomedicine as "an offshoot of nanotechnology" that deals with "highly specific medical interventions at the molecular scale for curing disease or repairing damaged tissues, such as bone, muscle, or nerve". That seems to be a definition of a therapeutic agent, a drug, don't you think?

Emphasis of nanotechnology is on generating new properties of materials through manipulating structures at the atomic and molecular level. In several medicine-related areas – diagnostics, imaging, biomaterials, vaccines - the application of nanotechnology appears to be successful. The same cannot be said about "nanotherapeutics".

It is argued that focusing on nanoscale events may be one way by which nanomedicine separates itself from other medical research. But does this make sense? Conventional drugs that have now been in use for more than a century typically have molecular weight not more than 500 Dalton. When expressed as spherical diameter, molecules of this molecular weight are about 1 nm in size. One is justified asking: Why the research that examined molecular and atomic interactions for decades is now called nanomedicine? And why calling it nanomedicine actually matters?

Taggart., *et al*. [4] tells us that "the first nanomedicine was approved for clinical use over 20 years ago". In fact, what it means is that a drug that happened to be called "nanomedicine" was approved; the sole novelty was in coining a new name. Since that time, the technology for engineering new "nano-materials" has advanced, but none of the progress has made an impact on generating effective targeted drug-delivery. The currently available systems that claim to be "nanocarriers" are no different from other, "run-of-the-mill" items based on other materials; they can access systemic circulation, concentrate at disease sites, sometime selectively bind to disease cells, and release the drug they carry. However, the ability of nanocarriers to deliver drugs specifically to disease targets is largely absent, and hence the potential for conversion to successful clinical treatment has been missing.

Conditions required for successful delivery of drugs to disease sites are well known, and need to be met fully to elicit a therapeutic effect [5]. Targeting the site of disease when attempting to treat cancer is of particular importance; to this end, identifying unique molecular features of particular disease, of particular cancer, has been identified as a key element towards making progress [6]. The need for applying Artificial Intelligence to solving this task is discussed in this issue [7]. Much more attention needs to be paid to molecular features of disease target when developing targeting system – "nano" or any other.

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