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GUEST EDITORIAL
Theranostic Nanomedicine

"Theranostics", a term derived from thera(py) + (diag)nostics to link the fields of diagnostics and therapeutics, is expected to improve patient outcomes and safety through a more personalized approach to medicine.

Theranostic nanomedicine has evolved to encompass integrated, biocompatible nanoparticle platforms that contain both therapeutic and imaging components. These nanoparticles may carry chemo-, radio- or gene therapeutics or combinations of these. Ideally, with appropriate intrinsic physicochemical properties or appropriate labels, these nanoparticles would allow us to diagnose disease and evaluate treatment efficacy, while we track the particles' pharmacokinetics and release of the drugs.

This special issue contains 28 Accounts of various inorganic nanoparticles (noble metal, metal oxide, and mesoporous silica nanoparticles, semiconductor quantum dots, and magnetic nanoparticles), lipid aggregates (including liposomes), and synthetic polymer systems (such as vesicles and micelles). Rigid inorganic nanoparticles often have unique physicochemical properties that allow applications in imaging and even therapy (such as photothermal ablation and magnetic fluid hyperthermia) after proper synthesis, coating, surface functionalization, and bioconjugation. These nanomaterials can also load gene- and chemotherapeutics. Liposomes and polymer nanoparticles bear certain flexibility, and they have the capacity to load various molecules, such as DNA, RNA, proteins, enzymes, and lipophilic organic drugs. They can also be further tagged with imaging labels.

For all nanotheranostics, there are a number of biological barriers in the living subject that challenge the efficacy of nanoparticle delivery: walls of blood vessels, physical entrapment of particles in organs, and removal of particles by phagocytic cells, just to name a few. An ideal theranostic nanoparticle would allow selective and rapid accumulation in diseased tissue(s), report biochemical and morphological characteristics of the tissue(s)/organ(s) of interest, deliver effective therapy, be safe and biodegradable with nontoxic byproducts, and lack immunogenicity.

Size, shape, rigidity, charge, and surface chemistry appear to have profound effects on the behavior of given nanoparticle formulations. There have been a number of ways, either synthetically or mechanically, to afford precise control and scalability. Due to the complexity of theranostic nanoparticles, which are the delivery vehicles and contain the cargo, targeting ligands, and imaging labels for delivery to specific tissues, cells or subcellular components, the clinical translation of these fancy materials is nontrivial. Robust processes that facilitate scale-up and manufacturing are a prerequisite. Studies of biological responses to nanomaterials need to consider many factors, including exposure levels, systemic accumulation, excretion profiles, tissue and organ distributions, and the characteristics (age, gender, etc.) of test subjects. It is essential to understand potential toxic responses, particularly long-term toxic effects, before they may be tested in human beings to image and treat diseases.

The collection of work reported in this special issue clearly demonstrates that multifunctional nanoparticles that combine imaging and therapeutic agents triggering gene or drug release at target sites when exposed to external stimuli can be very powerful in understanding and real-time visualization of drug delivery, drug release, and drug efficacy. Although more research is needed before theranostic nanomedicine can be implemented in the clinic, current research indicates that theranostic nanomedicine may revolutionize the diagnosis and treatment of many diseases and help to realize the potential of personalized medicine.

Xiaoyuan Chen
National Institutes of Health

Sanjiv S. Gambhir
Stanford University

Jinwoo Cheon
Yonsei University
Guest Editors

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