Opinion

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Biosensing Methods for the Rapid Detection of Important Biomarkers with the Assistance of Nanomaterials

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Description

Coronary Artery Diseases (CADs) account for the majority of morbidity and mortality in today's world, making them the leading cause of death. Even though cutting-edge technologies have improved our understanding of the cardiovascular system, the current methods of diagnosing and treating CADs remain constrained. As an arising cross-disciplinary methodology, nanotechnology has shown extraordinary potential for clinical use. The most recent developments in nanotechnology for CAD diagnosis will be discussed first in this review. With the assistance of nanomaterials, the sensitivity and specificity of biosensors for the detection of biomarkers as well as molecular imaging strategies like magnetic resonance imaging, optical imaging, nuclear scintigraphy, and multimodal imaging strategies have significantly increased. Lastly, the intrinsic antioxidative/anti-inflammatory and photoelectric/ photothermal properties of some of these nanomaterials in a complex plaque microenvironment make them pharmaceuticals for the treatment of atherosclerosis. In conclusion, novel nanotechnology-based clinical transformation research may continue to broaden the scope of nanoscale technologies for CAD diagnosis and treatment in the foreseeable future.

Coronary Atherosclerotic Heart Diseases or Coronary Artery Disease

In both developed and developing nations, Cardiovascular Diseases (CVDs) are the leading cause of mortality and morbidity. Atherosclerosis, a progressive disease characterized by a maladaptive immune response and dysregulation of cholesterol metabolism that leads to the formation of atherosclerotic plaques, is the most common cause of Cardiovascular Disease (CVD). The left and right coronary arteries, which are branches off the aortic root, supply the myocardium with oxygen-rich blood. Myocardial ischemia, hypoxia, and even necrosis can result from atherosclerotic lesions in the coronary arteries, which can cause lumen obstruction and stenosis. These conditions are referred to as coronary atherosclerotic heart diseases or coronary artery disease. Patients with CADs have better prognoses and longer survival times when they are diagnosed early, which increases their likelihood of successful treatment and eventual cure. When the heart is damaged or stressed, biomarkers related to CADs like cardiac Troponins (cTns), Myoglobin (Myo), Creatinine Kinase MB (CK-MB), C-Reactive Protein (CRP), and a number of microRNAs are released into the bloodstream.13 Developing precise, specific, simple, stable, and quick blood analyses for these molecules is one promising strategy for the early diagnosis of CADs. Mass spectrometry is habitually utilized for distinguishing likely biomarkers of Scoundrels yet is restricted by responsiveness and particularity because of the low degrees of biomarkers in human plasma. Because of these factors, combining biosensors and nanotechnologies may offer a promising approach to the diagnosis of CADs in their early stages. Through surface modification or structure optimization, the first can reduce nonspecific adsorption and provide high-affinity binding to specific molecules; the last option comprises of two sections: a transducer and a biological sensing component for converting data into electrical signals and identifying targets. Recognition molecules, such as antibodies, aptamers, or molecularly imprinted polymers, sense protein targets first. The sensing is then quantitatively detected using a variety of techniques, such as electrochemistry, electrochemiluminescence, fluorescent methods, colorimetry, surface-enhanced Raman scattering, and surface plasmon resonance technology.33 Nanomaterials with excellent optoelectronic properties significantly increase the detection sensitivity by For defining abnormal blood vessel walls with plaques and thrombi, Magnetic Resonance Imaging (MRI) is a popular noninvasive imaging method. In contrast to ultrasound and optical techniques, which are unable to penetrate deeply into the tissue, MRI does not use ionizing radiation, unlike PET or CT.

Sensitivity and Accuracy of Imaging Diagnosis in CADs

Biomedical research has benefited greatly from advances in optical imaging technology. It is attractive for imaging atherosclerotic plaques and clots due to its prominent features of spatial resolution (micrometer-range), high sensitivity of (sub) cellular localization, lack of radiation, and cost effectiveness. PET imaging has excellent sensitivity, but only limited spatial resolution and ion radiation. Due to their small size, increased diagnostic sensitivity, and reduced diagnostic time, nanomaterials have been utilized in the creation of more precise biosensors for the detection of CAD biomarkers. In the future, nano-biosensors might be useful in portable devices used in ambulances, hospitals, homes, chest pain centers, and ambulances. Second, contrasted and customary imaging specialists, nanomaterial-based sub-atomic tests can explicitly gather at atherosclerotic injuries through change with various objective moieties on the outer layer of nanoplatforms. The sensitivity and accuracy of imaging diagnosis in CADs will be further enhanced by combining these purposeful aggregations, the high loading capacity or photoelectromagnetic properties of nanomaterials, and multimodal imaging methods. Nanotechnology has also played a significant role in the treatment of CADs (particularly fragile plaques and thrombi) through a variety of strategies, including the repair of injured endothelium, anti-inflammatory, antioxidative, and platelet recruitment blockade. Most of the time, nanomaterials have served as multifunctional vehicles to deliver a variety of therapeutic drugs, including chemicals, proteins, peptides, and nucleic acids. In addition to enhancing drug bioavailability and shielding the drugs from enzymatic degradation and clearance in the bloodstream, these nanocarriers also possess remarkable specificity made possible by target moieties. In addition, nanomaterials' inherent ability to scavenge ROS and their photodynamic or photothermal properties continue to provide direct therapeutic options for CADs and intravascular implants.