What Is the Role of Nanotechnology in the Current COVID-19 Outbreak?

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The nanotechnology-based medicine platforms against coronavirus disease 2019 (COVID-19) bears hope for relief from the pandemic to save lives and mitigate the infection as part of a broader global public health agenda.

In a recent review article, an interdisciplinary research team discussed the potential of nanoparticles (NPs) as a drug itself or as a platform for the aim of drug and vaccine repurposing and development. They also looked at advanced detection strategies based on nanotechnology. Scientists are encouraged to design effective and cost-effective nanoplatforms for the prevention, diagnosis, and treatment of infectious diseases. The team has recently published their review in the journal Heliyon.

Over the last two decades, coronaviruses have become a serious epidemic problem with severe acute respiratory syndrome coronavirus (SARS), the Middle East respiratory syndrome (MERS) and the current pandemic of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Because of its high transmission rate and high reproduction number, COVID-19 has resulted in deadly outcomes.

Since December 2019, SARS-CoV-2 infection has caused over 143.5 million cases and over 3 million deaths. Yet, effective therapeutic drugs for COVID-19 are still unavailable. Due to the urgent nature of the need for a remedial agent to tackle COVID-19, drug repurposing is a promising strategy.

The role of nanotechnology in current COVID-19 outbreak.

To address the mitigation strategies against COVID-19, it is crucial to have a complete understanding of the virus, the host interaction and responses. Pathologically, it is known that the ACE2 (angiotensin-converting enzyme 2), a cell surface receptor in humans (over-expressed in the lung, heart, kidney, testis, intestine, and brain), is the main receptor of the SARS-CoV-2 virus. The viral receptor-binding domain (RBD) on the spike protein of the coronavirus binds to ACE2. Another receptor, CD147 (Basigin), as an extracellular matrix metalloproteinase inducer, is also considered to be a receptor for SARS-CoV-2 on the surface of cells, including epithelial cells, endothelial cells, leukocytes and red blood cells.

To design and evaluate successful drug or vaccine repurposing, the team first reviewed how similar SARS-CoV-2 is to other betacoronaviruses (the MERS-CoV and SARS-CoV) as a genotype and structure. The reviewers recommend drug repurposing based on the study of the information on the nucleotide sequence identity, sequence homology, similarity between proteins of the envelope, membrane, nucleocapsid, amino acid identities of the spike and RBD, mutations involving single amino acids, and function of every non-structural protein (nsp) and its sequence identity.

They conclude here that the drugs and vaccines can be selected based on those that share antiviral efficacy by the targeting of the envelope, membrane, nucleocapsid, S2 spike, RdRp (RNA dependent RNA polymerase), and helicase.

The reviewers note that accurate and early detection plays a critical role in limiting COVID-19 spread and prevents future epidemics. Nanotechnology, based on molecular techniques and specific pathogens targeting, may be very useful in this regard.

New nanotechnologies involve colloidal gold NPs to detect antibodies, an ultrasensitive chiro-immunosensor for viruses based on chiral AuNPs (Au NPs)-quantum dot (QDs) nanocomposites, and RNA stabilization kit (for room temperature), and nanoplatforms (polymeric NPs, chaperone-mediated ferritin nanoparticles, nanobodies) for the diagnosis of coronaviruses. In this review article, the reviewers have tabulated the current nano-based approaches for viral diagnosis and treatment.

Further, they discussed the properties of NPs for the COVID-19 treatment: nanomedicine used in vectors, biosensors, drug and gene delivery. They highlighted the physicochemical characteristics and the physiological advantages of the ‘nano’ regime in the therapeutic area. Specifically, they discussed each drug, including a few nonspecific drugs, that are currently in use as anti-SARS-CoV-2 agents.

The reviewers highlighted the role of the combination therapy and co-delivery systems such as the nanocarriers applied for the co-encapsulation of the candidate drugs such as remdesivir and hydroxychloroquine to treat COVID-19. Notably, they have presented the potential nano-based drugs that can be repurposed for the treatment of COVID-19.

Different types of carbon dots, gold nanorods (AuNRs), Fe2O3 NPs, nano-sponges, are investigated in pre-clinical assessments for COVID-19 therapy.

Nanotechnology also plays a powerful role in vaccine development. The reviewers shared, “A promising strategy in vaccine development is taking benefits of mRNA owing to mimicking the natural infection and the ability to combine multiple mRNAs into a single vaccine that resulted in the stimulation of a more potent immune response.”

Importantly, the reviewers also pointed that, while there are some concerns about their toxicities, nano drugs can act as a double-edged sword. They are also a promising tool to enhance the efficacy of drugs to inhibit virus attachment, fusion, replication, and infection or even restrain the inflammatory and damaging cascade following virus infection in some patients.

In the present paper, the reviewers discussed the diagnostic and therapeutic strategies for the other viruses which have similar mechanisms of action with SARS-CoV-2. It is a comprehensive review extensively covering the current strategies in nanotechnology that may be repurposed to act against the COVID-19 pandemic.

Read the original article on News Medical.