OPINION ARTICLE - OPEN ACCESS

International Journal Of Medical And Clinical Case Reports

Contents lists available at bostonsciencepublishing.us

International Journal Of Medical And Clinical Case Reports

Role of 'Nanotechnology' in Treatment of COVID-19

Kumari Priya[*], Dr. P.M. Chavhan[1]

[*]Applied Science, Amity School of Applied Sciences, Amity University Mumbai, Unnamed Road, Maharashtra 410221
[1]Asst. Professor, Amity University Maharashtra, Mumbai

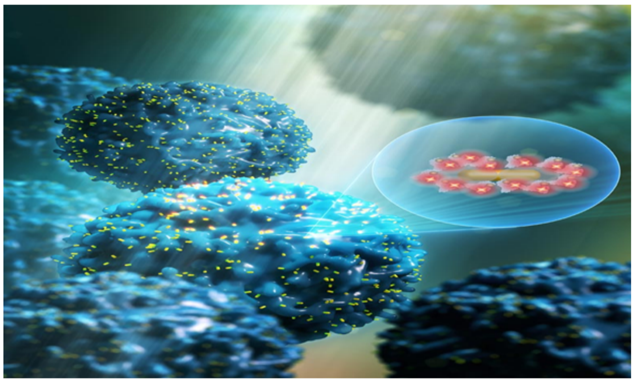
A R T I C L E I N F O

Article history:
Received 05 January 2021
Accepted 28 January 2021
Available online 10 February 2021

1. Background

Incidents of viral outbreaks have increased at an alarming rate over the past decade. The most recent human coronavirus known as COVID-19 (SARS-CoV-2) has already spread around the world [1]. However, the ratio between mortality and number of infections seems to be lower in this case in comparison to other human coronaviruses (such as severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) [2,3]. These outbreaks have tested the limits of healthcare systems and have posed serious questions about management using conventional therapies and diagnostic tools. In this regard, the use of nanotechnology offers new opportunities for the development of novel strategies in terms of prevention, diagnosis and treatment of COVID-19 and other viral infections [4].

Corona viruses belong to the subfamily, viz, Coronavirinae, which are enveloped and spherical viruses with a single-stranded RNA 'genome'. The recent outbreak of the novel beta-coronavirus responsible for COVID-19 in Wuhan, China, is probably associated with a seafood market. According to WHO's report [5], there had been over 80 million confirmed cases of COVID-19 globally by 16 June 2020, resulting in over 1.7 million deaths. However, compared to SARS-CoV, the human-to-human transmission of SARS-CoV-2 is much faster, which has already resulted in its spread around the world and led the WHO to declare the outbreak as a global pandemic on 11 March 2020 [6-9]. Although the number of infected patients is continuously increasing, consistent efforts are being made to develop more number of effective, targeted and safe drugs and vaccines to control this virus. Some scientists have been looking into the similarity of transmission between the novel SARS-CoV-2 and SARS-CoV to develop drugs targeted towards highly conserved key proteins, such as those involved in viral replication and proliferation. Examples of these proteins are spike, viral, and envelope proteins, as well as RNA proteases. Most of the currently available drugs for the treatment of viral infections fall in one of the followings classes: antiviral therapies, immune therapy, anti-inflammatory therapy, and other treatments. However, the development of new drugs is lagging the need for them because of the long process necessary to prove their efficacy and safety [10]. To overcome the limitations and to improve antiviral treatments, multidisciplinary research efforts are required toward the development of alternative antiviral therapies, targeting different phases in the viral replication cycle. In this regard, nanotechnology has attracted increasing attention and has already been investigated for potential use in prevention and/or treatment of viral infections [11].

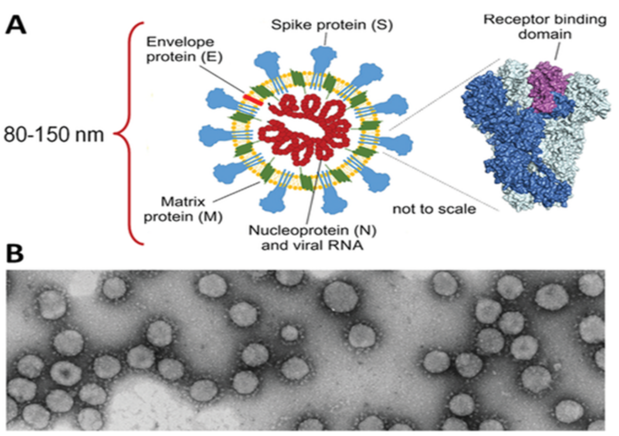


* Corresponding author.
E-mail address: priyachoudhary005679@gmail.com
(Kumari Priya).

Kumari Priya (2021) Role of 'Nanotechnology' in Treatment of COVID-19. Int J Med Clin Case Rep, 1(1); 1-4

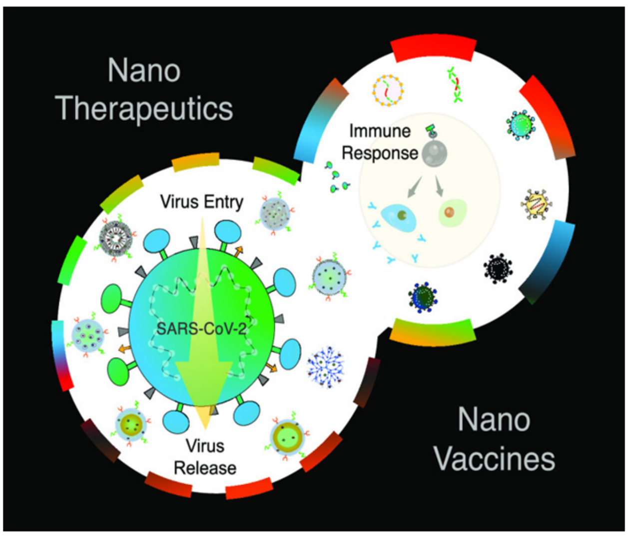
2. What is NANOTECHNOLOGY ?

In the face of the corona virus pandemic, it is time for the nanotechnology to shine and build on its experience with nano-scale materials and drug delivery to provide knowledge and tools for COVID-19 vaccine and therapeutic development [12,13].



As the quest for a COVID-19 vaccine continues, researchers working in other areas of science such as nanotechnology have joined the battle against the virus.

The ongoing COVID-19 crisis does not mark the first time that nanomaterials have been highlighted for their ability to limit the spread of viruses. Surfaces coated with polymers containing nanoparticles of metals such as copper can release metal ions, which are known for their antiviral activity and have already been suggested for use in certain areas. Nanotechnology offers a safer alternative to the use of toxic chemicals such as disinfectants in medical settings. Such coatings are far more convenient than other non-toxic disinfectant measures such as irradiation with Ultraviolet (UV) light [14-16]. These nanomaterial coatings and alloys confer antiviral and antibacterial properties through the release of ions, which disrupt the operation of living cells.

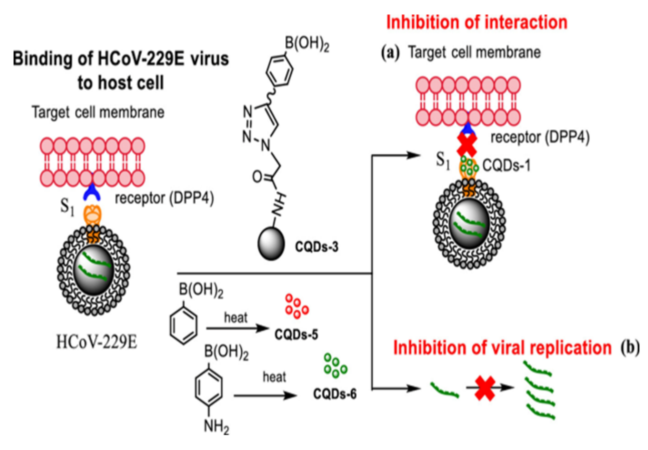


Characteristics of Nanotechnology and Nanomaterials [12]

- Improved and virus disabling air filtration.
- Low-cost, scalable detection methods for the detection of viral particles
- Enhanced personal protection equipment (PPE) including facemasks.
- New antiviral vaccine and drug delivery platforms.
- New therapeutic solutions.

Nanoparticles' Design for Virus Inhibition

Nanomaterials can be designed to have different functional groups on the surface and to bond with specific cell receptors, and these approaches can be used to block the contact of the virus with target cells.



Working Principle

Nanotechnology could help the fight against COVID-19 through different approaches, such as avoiding viral contamination and spray by:

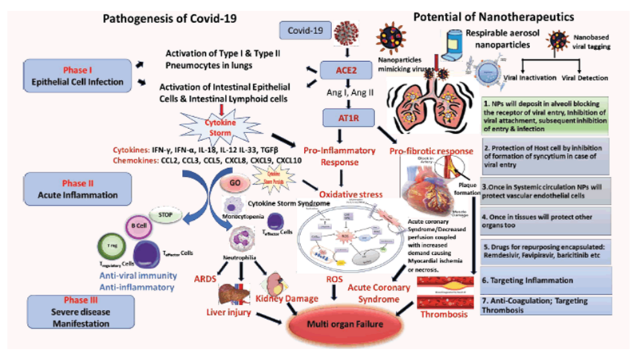
a. Design of infection-safe Personal Protective Equipment (PPE) to enhance the safety of healthcare workers and development of effective antiviral disinfectants and surface coatings, which are able to inactivate the virus and prevent its spread.

b. Design of highly specific and sensitive nano-based sensors to quickly identify the infection or immunological response.

c. Development of new drugs, with enhanced activity, decreased toxicity and sustained release, as well as tissue-target, for example, to the lungs.

d. Development of a nano-based vaccination to boost humoral and cellular immune responses.

This is where nanotechnology offers a lot of opportunities for the development of more efficient and promising disinfectant systems.



Development of Nanomaterials for PPE

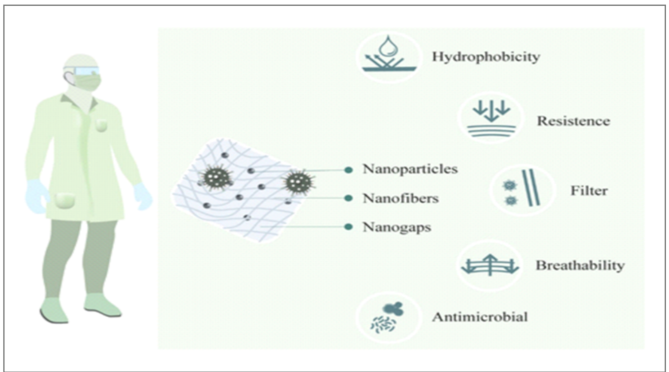
According the United States Centres for Disease Control and Prevention (CDC), the main factors for the spread of COVID-19 is close contact (person-to-person) and respiratory droplets produced by infected persons. The use of appropriate PPE, such as masks and gloves, is also important to combat the spread of the coronavirus [17-20]. However, there are many issues regarding the availability and appropriateness of PPE products, for example facemasks not fitting properly or not suitable for restricting airborne viral particles. Nanotechnology is offering new materials that are more comfortable, resistant, and safer means for protection against biological and chemical risks. Facemasks, lab or medical aprons and others have been nanoengineered to provide new functions. For instance, hydrophobicity and antimicrobial activity without affect-

Kumari Priya (2021) Role of 'Nanotechnology' in Treatment of COVID-19. Int J Med Clin Case Rep, 1(1): 1-4

ing the material's texture or breathability. The hydrophobicity of PPE products can provide an effective barrier on its own against airborne droplets emitted during coughing or sneezing.

The use of nanomaterials can build antimicrobial properties in textiles used in PPE. This strategy has been used to prevent the growth of microorganisms in clothes. The surfaces modified by nanoscale biocides, such as quaternary ammonium or quaternary phosphonium salts, polymers or peptides, can control microorganisms through oxidation of the microbial membrane.

One of the best examples of how nanotechnology can improve personal protection is the production of facemasks. Traditional facemasks have a gap between the fibers, averaging 10-30 μm that is inadequate for avoiding virus contact, and the reduction of this gap between the fibers cause a reduction of breath and increases of both temperature and pressure, making it uncomfortable for the user. Many frontline healthcare workers have been suffering from skin damage due to the continuous use of facemasks. The use of nanomaterials, such as nanofibers, can reduce breathing resistance and drop the pressure to provide wearing comfort, but at the same time protect against small particles ($<$ 50 nm). This provides much better protection than traditional surgical facemasks, which do not offer protection against particles 10–80 nm in size. This use of nanomaterial for facemasks has two positive points. First, facemask protection works as a filter plus microbicidal agent, resulting in blocking and inactivating/killing the pathogens. Second, the management of this material after its use becomes safer. Once the biggest part of pathogens is destroyed in contact with the masks, it reduces the probability of contamination during the undressing process. For gloves, some products, based on silver nanoparticles, are available and are sold for their antibacterial effects [21-25].



3. Global NANOTECHNOLOGY Market

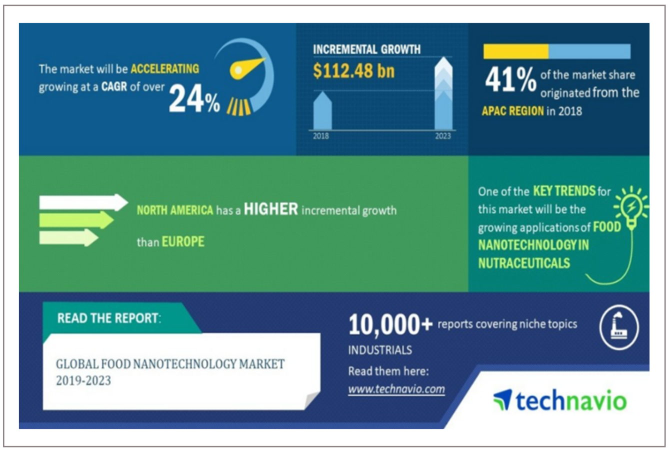
Nanotechnology continues to have a broad and fundamental impact on nearly all sectors of the global economy, namely electronics, energy, biomedical, cosmetics, defense, automotive and agriculture among others. Nanotechnology continues to have a broad and fundamental impact on nearly all sectors of the global economy, namely electronics, energy, biomedical, cosmetics, defense, automotive and agriculture among others. The global nanotechnology market is expected to exceed US$ 125 Billion mark by 2024.

Global Nanotechnology Market & Forecast to 2024 - By Component

- By component, the nanomaterials captured highest share of the global nanotechnology market.
- Nanoparticles holds over 85% share of the global nanomaterials market.
- The nanotools accounted for second highest share of the nanotechnology market.
- Nanolithography tools dominate the global nanotools component market.
- Nanodevices segment captured least share of the global nanotechnology market.

Global Nanotechnology Market & Forecast to 2024 - By Applications

- The top three applications of nanotechnology are electronics, energy and biomedical. Together, they account for over 70% share of the global nanotechnology market.
- The largest application for nanotechnology is electronics.
- The energy application captured second highest share of the nanotechnology market, being followed by biomedical application.
- The cosmetic industry is one of the most enthusiastic early adopters of nanotechnology.
- The global defence application market for nanotechnologies was valued at nearly US$ 3 Billion in 2017.
- Automotive application captured nearly 5% share of the global nanotechnology market.



4. Conclusion

Nanotechnology through its numerous applications is an efficient and cost-effective tool to be used to improve these tests for detection of SARS-CoV-2. A variety of nanomaterials, including metallic nanoparticles, polymeric nanoparticles, silica nanoparticles, carbon nanotubes, and quantum dots, are already used for virus detection. For the development of these systems for virus detection, the surface of the nanoparticle was modified with biomolecules derived from the virus, for example DNA, RNA, antibody, antigen (hemagglutinin antigen H1N1), peptide or pentabody (avian influenza virus–pVHH3B). The high surface and volume ratios of nanomaterials improve the interactions between the sensor and the analyte, increasing the detection limit and decreasing the detection time.

Therefore, the use of nano-based formulations has indicated a great potential for the control of viral infections, where nanoparticles can both enhance the efficacy of an antiviral drug and also reduce its toxicity. Nanotechnology has also been used to enhance the efficacy of antiviral drugs by overcoming their low bioavailability. nanotechnology has already been shown to enhance diagnostics, protection and therapies in other viral infections; therefore, there is a good chance that, with more R&D, it will revolutionize the fight against COVID-19 or any other future outbreaks, offering processes, materials and tools to enhance sensitivity, speed and reliability of diagnosis, as well as providing more efficacious options for therapies.

Funding

None

Conflict of Interest

None

References

1. Du Toit A. Outbreak of a Novel Coronavirus. Nat. Rev. Microbiol. 2020, 18, 123–123. 10.1038/s41579-020-0332-0. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
2. Wu D.; Wu T.; Liu Q.; Yang Z. The SARS-CoV-2 Outbreak: What We Know. Int. J. Infect. Dis. 2020, 94, 44–48. 10.1016/j.ijid.2020.03.004. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
3. Coronavirus Disease 2019 (COVID-19) Situation Report-68. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200328-sitrep-68-covid-19.pdf?sfvrsn=384bc74c_2 (accessed 2020-04-11).
4. Callaway E. Time to Use the P-Word? Coronavirus Enters Dangerous New Phase. Nature 2020, 10.1038/d41586-020-00551-1. [CrossRef] [Google Scholar]
5. Cucinotta D.; Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomed. 2020, 91, 157–160. 10.23750/abm.v91i1.9397. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
6. Pulla P. Covid-19: India Imposes Lockdown for 21 Days and Cases Rise. BMJ. [Br. Med. J.] 2020, m1251.10.1136/bmj.m1251. [PubMed] [CrossRef] [Google Scholar]
7. Lau H.; Khosrawipour V.; Kocbach P.; Mikolajczyk A.; Schubert J.; Bania J.; Khosrawipour T. The Positive Impact of Lockdown in Wuhan on Containing the COVID-19 Outbreak in China. J. Travel Med. 2020, 10.1093/jtm/taaa037. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
8. World Economic Prospects Monthly (2/2020) Economic Outlook. Econ. Outlook 2020, 44, 1–33. [Google Scholar]
9. McKibbin W. J.; Fernando R. The Global Macroeconomic Impacts of COVID-19: Seven Scenarios. SSRN Electronic J. 2020, 10.2139/ssrn.3547729. [CrossRef] [Google Scholar]
10. Zhou P.; Yang X. L.; Wang X. G.; Hu B.; Zhang L.; Zhang W.; Si H. R.; Zhu Y.; Li B.; Huang C. L.; Chen H. D.; Chen J.; Luo Y.; Guo H.; Jiang R. D.; Liu M. Q.; Chen Y.; Shen X. R.; Wang X.; Zheng X. S.; et al. A Pneumonia Outbreak Associated with a New Coronavirus of Probable Bat Origin. Nature 2020, 579, 270–273. 10.1038/s41586-020-2012-7. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
11. Song Z.; Xu Y.; Bao L.; Zhang L.; Yu P.; Qu Y.; Zhu H.; Zhao W.; Han Y.; Qin C. From SARS to MERS, Thrusting Coronaviruses into the Spotlight. Viruses 2019, 11, 59.10.3390/v11010059. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
12. Cui J.; Li F.; Shi Z.-L. Origin and Evolution of Pathogenic Coronaviruses. Nat. Rev. Microbiol. 2019, 17, 181–192. 10.1038/s41579-018-0118-9. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
13. Zheng Y.-Y.; Ma Y.-T.; Zhang J.-Y.; Xie X. COVID-19 and the Cardiovascular System. Nat. Rev. Cardiol. 2020, 17, 259–260. 10.1038/s41569-020-0360-5. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
14. Bangash M. N.; Patel J.; Parekh D. COVID-19 and the Liver: Little Cause for Concern. Lancet Gastroenterol. Hepatol. 2020, 5, 529–530. 10.1016/S2468-1253(20)30084-4. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
15. Zhang C.; Shi L.; Wang F.-S. Liver Injury in COVID-19: Management and Challenges. Lancet Gastroenterol. Hepatol. 2020, 5, 428–430. 10.1016/S2468-1253(20)30057-1. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
16. Riviere G.; Michaud A.; Breton C.; VanCamp G.; Laborie C.; Enache M.; Lesage J.; Deloof S.; Corvol P.; Vieau D. Angiotensin-Converting Enzyme 2 (ACE2) and ACE Activities Display Tissue-Specific Sensitivity to Undernutrition-Programmed Hypertension in the Adult Rat. Hypertension 2005, 46, 1169–1174. 10.1161/01.HYP.0000185148.27901.fe. [PubMed] [CrossRef] [Google Scholar]
17. Cheng Y.; Luo R.; Wang K.; Zhang M.; Wang Z.; Dong L.; Li J.; Yao Y.; Ge S.; Xu G. Kidney Impairment Is Associated with In-Hospital Death of COVID-19 Patients. Kidney Int. 2020, 97, 829.10.1016/j.kint.2020.03.005. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
18. Wong S. H.; Lui R. N.; Sung J. J. Covid-19 and the Digestive System. J. Gastroenterol. Hepatol. 2020, 35, 744–748. 10.1111/jgh.15047. [PubMed] [CrossRef] [Google Scholar]
19. Rothan H. A.; Byrareddy S. N. The Epidemiology and Pathogenesis of Coronavirus Disease (COVID-19) Outbreak. J. Autoimmun. 2020, 109, 102433.10.1016/j.jaut.2020.102433. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
20. Heymann D. L.; Shindo N. COVID-19: What Is Next for Public Health?. Lancet 2020, 395, 542–545. 10.1016/S0140-6736(20)30374-3. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
21. Masters P. S. The Molecular Biology of Coronaviruses. Adv. Virus Res. 2006, 66, 193–292. 10.1016/S0065-3527(06)66005-3. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
22. Liu D. X.; Fung T. S.; Chong K. K.-L.; Shukla A.; Hilgenfeld R. Accessory Proteins of SARS-CoV and Other Coronaviruses. Antiviral Res. 2014, 109, 97–109. 10.1016/j.antiviral.2014.06.013. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
23. Mortola E.; Roy P. Efficient Assembly and Release of SARS Coronavirus-Like Particles by a Heterologous Expression System. FEBS Lett. 2004, 576, 174–178. 10.1016/j.febslet.2004.09.009. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
24. Wang C.; Zheng X.; Gai W.; Zhao Y.; Wang H.; Wang H.; Feng N.; Chi H.; Qiu B.; Li N.; et al. MERS-CoV Virus-Like Particles Produced in Insect Cells Induce Specific Humoural and Cellular Imminity in Rhesus Macaques. Oncotarget 2017, 8, 12686–12694. 10.18632/oncotarget.8475. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
25. de Haan C. A.; Rottier P. J. Molecular Interactions in the Assembly of Coronaviruses. Adv. Virus Res. 2005, 64, 165–230. 10.1016/S0065-3527(05)64006-7. [PMC free article] [PubMed] [CrossRef] [Google Scholar]