Nanotechnology and Nanomaterials Research

Mini Review

DOI: https://doi.org/10.47275/2692-885X-110
Volume 2 Issue 1

Nanotechnology Role to Combat COVID-19

Lopez AP*

Department of Genetics, Molecular Biology Laboratory, Universidad de Buenos Aires, Argentina

Abstract

Incidents of viral epidemics have escalated at an alarming rate during the previous decades. The most recent human coronavirus identified as COVID-19 (SARS-CoV-2) has already spread over the world. These epidemics constrain healthcare systems about employing standard medicines and diagnostic technologies. In this context, the application of nanotechnology provides new prospects for the development of novel techniques in terms of diagnosis, prevention, diagnosis and treatment of COVID-19. This review discusses nanotechnology-based strategies for diagnosis, prevention, and treatment of COVID-19, including nanomaterials for surface sterilization, face masks, personal protective equipment, disinfectants, nanocarrier systems and diagnostic systems for treatments and vaccine development. It presents a viewpoint on how nanotechnology may be utilized to battle against COVID-19.

***Correspondence to:** Ariel Pablo Lopez, Department of Genetics, Molecular Biology Laboratory, Universidad de Buenos Aires, Argentina, E-mail: aplopez@prensamedica.com.ar

Citation: Lopez AP (2021) Nanotechnology Role to Combat COVID-19. Nanotechnol Nanomater Res, Volume 2:1. 110. DOI: https://doi.org/10.47275/2692-885X-110

Received: March 05, 2021; **Accepted:** March 20, 2021; **Published:** March 27, 2021

Introduction

It was discovered in December 2019 that COVID-19 is caused by SARS-CoV-2 (the new coronavirus originally discovered in Wuhan, China [1, 2]. An important feature of the virus is its ability to rapidly change in order to adapt to different epidemiological settings [3]. The diagnosis and treatment of people with COVID-19 are complicated by the disease's heterogeneity, which makes it difficult for medical practitioners to narrow down the underlying cause. All kinds of techniques and approaches are needed to understand the host-pathogen interaction and illness in order to produce successful medications and therapies. By offering vaccinations and carriers based on nanoparticles, nanomedicine has the potential to reduce the disease burden [4, 5]. A range of diseases, including respiratory viruses, papillomavirus, herpes virus and HIV, have been successfully treated with nanotechnology in preclinical investigations. To help with the COVID-19, nanotechnology is a top priority in this situation. The nano-regime encompasses all substances with a diameter less than one micrometre. The virus's size is identical to that of the nanomaterial, making it efficient in attacking it. Moreover, the tiny size of the nanomaterials allows them to be excellent delivery moieties, facilitating targeted drug and gene delivery and modification, and also enhancing interactions between analyte and sensor i.e. permitting rapid and accurate viral detection [6, 7].

Nanotechnology Strategies for Disinfection of Surfaces and PPE

As a highly contagious virus, COVID-19 may spread via a variety of vectors [8]. Micro-droplets released primarily by individuals or surfaces contaminated with SARS-CoV-2 have been established in recent research to be the primary mode of SARS-CoV-2 transmission. Depending on the surface, the human coronavirus can remain for up to 9 days and at temperatures exceeding 30°C, according to the study of Kampf G (2020) [9]. Using personal protective equipment (PPE) and disinfectants and sanitizers is critical in this situation [10]. In order to reduce the risk of exposure to pathogens, the World Health Organization (WHO) suggests using physical and chemical variables, such as masks and hygienic personal care practises, as well as disinfection of frequently-touched surfaces. When this is not possible, it is vital to design disinfectants and sanitizers that can withstand repeated washing and friction, and that are non-toxic in addition to long-lasting. Engineered water nanostructures (EWNS) based on electrospray and aqueous suspension ionisation of several active substances were produced by Vaze N, et al. (2019) [11]. There was a considerable decrease in pathogen concentration, according to the findings (including H1N1 influenza). Based on titanium dioxide and silver nanoparticles, Nanotech Surface Company produces a disinfection composition. When it comes to disinfecting surfaces, a business claims that its compound was employed during the COVID-19 epidemic. Surfaces such as door knobs, elevator buttons, and mobile phones remain germ-free thanks to the nanoparticles' oxidation reaction, which is potentialized by light.

Antiviral disinfectants and surface coatings that can inactivate and prevent the spread of COVID-19 can be developed using nanotechnology. This includes the design of infection-safe personal protective equipment (PPE) for healthcare workers, and the development of effective antiviral disinfectants and surface coatings. Textiles used in personal protective equipment (PPE) can be made antibacterial with the use of nanoparticles [12, 13]. In order to inhibit the growth of microbes on clothing, this method has been employed. Controlling microbes by the oxidation of the microbial membrane can be achieved on surfaces modified by nanoscale biocides, such as quaternary ammonium or quaternary phosphonium salts, polymers or peptides. When utilised in filters or membranes, silica hybrid silver nanoparticles can give superior protection against tiny particles (50 nm) than typical surgical facemasks [14].

There are two advantages of using nanomaterial in facemasks. Filtering and microbicidal agents in facemasks prevent infections from entering and destroying them. Second, after viruses have been eliminated in contact with the masks, it is safer to handle the material after its usage. This reduces the risk of contamination during the undressing procedure. Additionally, the patents on this technology allow for the development of various types of personal protective equipment (PPE) that can assist prevent the transmission of diseases, such as visiting aprons, medical and lab jackets, bedsheets and foot protection [14, 15].

Nanotechnology Strategies in Diagnosing COVID-19

For diagnostic applications, metallic nanoparticles are more commonly used. When AuNPs (gold nanoparticles) coated with antisense oligonucleotides interact with RNA specimens within 10 minutes, selective naked-eye detection of COVID-19 is achievable. Detection and diagnosis of COVID-19 positive cases is possible without the use of specialised instruments and equipment. A major constraint in the diagnosis of persons arises when a viral load is first represented or when a mutation develops during the propagation phase [16]. Many biosensors now incorporate nanotechnology-based probes [17], which increase the analytical sensitivity for diagnosis by obtaining electrical, optical, or catalytical capabilities from the sensor's usage of nanomaterials [18, 19]. It was found that gold nanoparticles functionalized with thiol-modified surface-modified probes, which hybridise with their target, did not aggregate with salts and therefore did not undergo colour change, and this platform can therefore be easily adapted for the diagnosis of infectious diseases such as the bacterium COVID-19 [20].

Nanotechnology Based Treatments for COVID-19 Infections and Vaccine Development

Nano therapeutic materials have been created to increase the effectiveness of COVID-19 therapy. Some examples of these include the development of biodegradable nanoparticles that are nontoxic and stable, surface modification of nanoparticles by conjugation of PEG to capping agents and targeting moieties to minimise adverse effects of therapy, and the fabrication and testing of polymeric nanoparticles with rapid and high mucus penetration features. When it comes to the treatment of coronavirus infection, potential antiviral agents and drug delivery platforms such titanium dioxide, silver colloid and diphyllin nanoparticles are among the nanomaterials being studied [21, 22]. When used in conjunction with nano-based gene therapy such as small interfering RNAs (siRNAs), coronavirus replication can be drastically reduced [23, 24]. Nanoparticles, including as dendrimers, liposomes, carbon nanotubes, polymer-based materials, and inorganic nanoparticles, can be combined with different antigens in nano-based immunotherapy [25]. Gold nanoparticles coated with the swine transmissible gastroenteritis virus have been utilised to activate macrophages, promote interferon production, and boost anti-coronavirus neutralising antibody levels in vaccinated individuals [26, 27]. Encapsulated in positively charged LNPs (lipid nanoparticles), the COVID-19 mRNA-based vaccines (manufactured by BioNTech-Pfizer and Moderna) are resistant to RNase-mediated degradation, stable self-assembling particles that may be given through numerous routes.

Future Strategies by Nanotechnology for COVID-19

Coronavirus antiviral treatment is becoming more dependent on nanotechnology. Nanomaterials have been designed to enhance the transport of bio therapeutics through the physiological barriers. To tackle existing and future mutant coronaviruses, a wide spectrum of prospective nanodevices, such as nanosensors, nanobased vaccinations and smart nanomedicines, provides considerable promise.

References

1. Chen N, Zhou M, Dong X, Qu J, Gong F, et al. (2020) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 395: 507-513. https://doi.org/10.1016/s0140-6736(20)30211-7
2. Liu Y, Gayle AA, Wilder-Smith A, Rocklöv J (2020) The reproductive number of COVID-19 is higher compared to SARS coronavirus. J Travel Med 27: taaa021. https://doi.org/10.1093/jtm/taaa021
3. Kang S, Peng W, Zhu Y, Lu S, Zhou M, et al.(2020) Recent progress in understanding 2019 novel coronavirus (SARS-CoV-2) associated with human respiratory disease: detection, mechanisms and treatment. Int J Antimicrob Agents 55: 105950. https://doi.org/10.1016/j.ijantimicag.2020.105950
4. Lembo D, Donalisio M, Civra A, Argenziano M, Cavalli R (2018) Nanomedicine formulations for the delivery of antiviral drugs: a promising solution for the treatment of viral infections. Expert Opin Drug Deliv 15: 93-114. https://doi.org/10.1080/17425247.2017.1360863
5. Singh L, Kruger HG, Maguire GEM, Govender T, Parboosing R (2017) The role of nanotechnology in the treatment of viral infections. Ther Adv Infect Dis 4: 105-131. https://doi.org/10.1177/2049936117713593
6. Gera M, Sharma N, Ghosh M, Huynh DL, Lee SJ, et al. (2017) Nanoformulations of curcumin: an emerging paradigm for improved remedial application. Oncotarget 8: 66680-66698. https://doi.org/10.18632/oncotarget.19164
7. Praditya D, Kirchhoff L, Brüning J, Rachmawati H, Steinmann J, et al. (2019) Anti-infective properties of the golden spice curcumin. Front Microbiol 10: 912. https://doi.org/10.3389/fmicb.2019.00912
8. Herron JBT, Hay-David AGC, Gilliam AD, Brennan PA (2020) Personal protective equipment and Covid 19-a risk to healthcare staff? Br J Oral Maxillofac Surg 58: 500-502. https://doi.org/10.1016/j.bjoms.2020.04.015
9. Kampf G (2020) Potential role of inanimate surfaces for the spread of coronaviruses and their inactivation with disinfectant agents. Infect Prev Pract 2: 100044. https://doi.org/10.1016/j.infpip.2020.100044
10. Chang A, Schnall AH, Law R, Bronstein AC, Marraffa JM, et al. (2020) Cleaning and disinfectant chemical exposures and temporal associations with COVID-19—National Poison Data System, United States, January 1, 2020–March 31, 2020. MMWR Morb Mortal Wkly Rep 69: 496-498. https://doi.org/10.15585/mmwr.mm6916e1
11. Vaze N, Pyrgiotakis G, McDevitt J, Mena L, Melo A, et al. (2019) Inactivation of common hospital acquired pathogens on surfaces and in air utilizing engineered water nanostructures (EWNS) based nano-sanitizers. Nanomed Nanotechnol Biol Med 18: 234-242. https://doi.org/10.1016/j.nano.2019.03.003
12. Yetisen AK, Qu H, Manbachi A, Butt H, Dokmeci MR et al. (2016) Nanotechnology in textiles. ACS Nano 10: 3042-3068. https://doi.org/10.1021/acsnano.5b08176
13. El-Nahhal IM, Salem J, Anbar R, Kodeh FS, Elmanama A (2020) Preparation and antimicrobial activity of ZnO-NPs coated cotton/starch and their functionalized ZnO-Ag/cotton and Zn(II) curcumin/cotton materials. Sci Rep 10: 5410. https://doi.org/10.1038/s41598-020-61306-6
14. Mansi A, Boccuni F, Iavicoli S (2019) Nanomaterials as a new opportunity for protecting workers from biological risk. Ind Health 57: 668-675. https://doi.org/10.2486/indhealth.2018-0197
15. Srinivas AD, Peng C, Mittal AC, Agarwal P (2018) Surfaces having particles and related methods. https://patents.google.com/patent/US20140041905A1/en. Accessed 27 Apr 2020.
16. Park S, Ko YS, Lee SJ, Lee C, Woo K, et al. (2018) Inactivation of influenza A virus via exposure to silver nanoparticle-decorated silica hybrid composites. Environ Sci Pollut Res int 25: 27021-27030. https://doi.org/10.1007/s11356-018-2620-z
17. Kanovsky M (2016) Antimicrobial fabric materials for use in safety masks and personal protection clothing.

18. Moitra P, Alafeef M, Dighe K, Frieman MB, Pan D (2020) Selective naked-eye detection of SARS-CoV-2 mediated by N gene targeted antisense oligonucleotide capped plasmonic nanoparticles. ACS Nano 14: 7617-7627. https://doi.org/10.1021/acsnano.0c03822

19. Chen L, Liang J (2020) An overview of functional nanoparticles as novel emerging antiviral therapeutic agents. Mater Sci Eng C Mater Biol Appl 112: 110924. https://doi.org/10.1016/j.msec.2020.110924

20. Layqah LA, Eissa S (2019) An electrochemical immunosensor for the corona virus associated with the Middle East respiratory syndrome using an array of gold nanoparticle-modified carbon electrodes. Microchim Acta 186: 224. https://doi.org/10.1007/s00604-019-3345-5

21. Łoczechin A, Séron K, Barras A, Giovanelli E, Belouzard S, et al. (2019) Functional carbon quantum dots as medical countermeasures to human coronavirus. ACS Appl Mater Interfaces 11: 42964-42974. https://doi.org/10.1021/acsami.9b15032

22. Hu CMJ, Chen YT, Fang ZS, Chang WS, Chen HW (2018) Antiviral efficacy of nanoparticulate vacuolar ATPase inhibitors against influenza virus infection. Int J Nanomed 13: 8579-8593. https://doi.org/10.2147/ijn.s185806

23. Rabaan AA, Al-Ahmed SH, Haque S, Sah R, Tiwari R, et al. (2020) SARS-CoV-2, SARS-CoV, and MERS-COV: a comparative overview. Infez Med 28: 174-184.

24. Ceccarelli M, Berretta M, Venanzi Rullo E, Nunnari G, Cacopardo B (2020) Differences and similarities between Severe Acute Respiratory Syndrome (SARS)-CoronaVirus (CoV) and SARS-CoV-2. Would a rose by another name smell as sweet? Eur Rev Med Pharmacol Sci 24: 2781-2783. https://doi.org/10.26355/eurrev_202003_20551

25. Duncan SA, Dixit S, Sahu R, Martin D, Baganizi DR, et al. (2019) Prolonged release and functionality of interleukin-10 encapsulated within PLA-PEG nanoparticles. Nanomaterials 9: 1074. https://doi.org/10.3390/nano9081074

26. Kim CG, Kye YC, Yun CH (2019) The role of nanovaccine in cross-presentation of antigen-presenting cells for the activation of CD8+ T cell responses. Pharmaceutics 11: 612. https://doi.org/10.3390/pharmaceutics11110612

27. Xiang SD, Scholzen A, Minigo G, David C, Apostolopoulos V, et al. (2006) Pathogen recognition and development of particulate vaccines: does size matter? Methods 40: 1-9. https://doi.org/10.1016/j.ymeth.2006.05.016