Wondering How Technologies from Nano to Blockchain Can Help in Coronavirus Era?

2020-05-03

Dr. Mihalis Kritikos, a Policy Analyst at the European Parliament working as a legal/ethics advisor on science and technology issues, has carried out an in-depth analysis on the main features, significance, and applications of ten existing technologies, including artificial intelligence, blockchain, open-source techs, telehealth, 3D printing, gene-editing, nanotechnology, synthetic biology, drones, and robots, in monitoring and containing the rapid spread the novel coronavirus. Moreover, this report comes up with the legal and regulatory challenges and the key socio-ethical dilemmas of their applications in a public-health emergency context.

Covid-19 is spreading rapidly over the globe, but there are few specific tools available to control the growing pandemic and to treat those who are sick. Quarantine, isolation, and infection-control measures are all that can be used to prevent the spread of the disease and those who become ill must rely on supportive care.

This analysis examines in detail how nanotechnology domains are helping the fight against this pandemic disease by means of innovative applications. It also sheds light on the main legal and regulatory challenges, but also on the key socio-ethical dilemmas that the various uses of nanotechnology pose when applied in a public-health emergency context such as the current one.

What is lacking is a specific antiviral agent to treat the infected and subsequently, decrease viral shedding and transmission. Nano-based products are currently being developed and deployed for the containment, diagnosis, and treatment of Covid-19. An experimental nano-vaccine has become the first vaccine to be tested in a human trial. However, is nanotechnology mature enough to address clinical needs efficiently in the context of a pandemic?

Nanotechnology is a multidisciplinary field that makes use of nano-sized particles and

devices for various applications, including diagnostics, targeted drug delivery, and the production of new therapeutic materials. Nanoparticles such as gold and silver have been used in biomedical and diagnostic applications, for the detection of viral particles for instance.

Nanotechnology has been shown to help in treating viral infection by means of various mechanisms. Nanoparticles can act as antiviral drug delivery systems; they can interact and bind to a virus and thereby prevent it from attaching and entering the host cell, and they can be designed to exhibit antiviral effects. Altogether, the use of nanotechnology in the development of new medicines has been recognized as a key enabling technology, capable of providing new and innovative medical solutions to address unmet medical needs.

Nanotechnology in Battle Against Coronavirus ...

Potential impacts and developments

Nanomedicine has already been used in drug delivery. In the case of an RNA-based vaccine, which consists of messenger RNA (ribonucleic acid) strands, lipid nanoparticles have been used to pack the RNA molecule and deliver it within the body.

While no RNA vaccine has ever been licensed, a US-based biotechnology company specializing in messenger RNA therapeutics recently announced that its mRNA-based vaccine candidate (mRNA-1273) for the novel coronavirus disease (Covid-19) had just entered Phase 1 study. Novavax, meanwhile, also recently initiated the development of a vaccine candidate for Covid-19, using its proprietary recombinant nanoparticle vaccine technology.

A group of scientists from the University of Washington's Institute for Protein Design have been manufacturing nanoparticles to create a more efficient vaccine against Covid-19 via computational models to predict and design self-assembling proteins. Furthermore, a group of researchers from the University of Lille and Ruhr-University Bochum have recently demonstrated that the addition of gold nanoparticles and carbon quantum dots (CQDs) to the cell culture medium before and during infection with coronaviruses considerably reduced the

infection rate of the cells.

Sona Nanotech has developed a lateral-flow screening test to identify the novel Coronavirus, 2019-nCoV, in less than 15 minutes, applying its proprietary nanorod technology.

The European Commission and the Spanish Ministry of Science and Innovation meanwhile recently announced their intention to fund a research project, CONVAT, to develop a rapid Covid-19 test based on nanobiosensors. CONVAT will provide a new device based on optical biosensor nanotechnology that will allow the detection of coronavirus directly from the patient's sample within about 30 minutes, without the need for testing in centralized clinical laboratories.

The project also aims to extend beyond the current pandemic and human diagnosis, with plans for the new biosensor device to also be used for the analysis of different types of coronavirus present in reservoir animals, such as bats, in order to observe and monitor possible evolutions of these viruses and prevent future outbreaks in humans.

Sonovia has developed a nanoparticle-infused fabric that can be used in medical masks, protective clothing and hospital materials, while researchers at the Hong Kong University of Science and Technology have developed a multilevel antimicrobial polymer (MAP-1) coating that is effective in killing in huMAN cells) for viral inhibition that can effectively degrade SARS-CoV-2 sequences and live influenza A virus (IAV) genome in human lung epithelial cells has recently been demonstrated.

The scientists involved state that the PAC-MAN approach is potentially a rapidly implementable pan-coronavirus strategy to deal with emerging pandemic strains. Moreover, researchers at the New York Genome Center have recently developed a new kind of CRISPR screen technology to target RNA, including RNA viruses like coronavirus. This novel CRISPR-based editing tool, which enables researchers to target mRNA and knockout genes without altering the genome, was created by using the CRISPR-Cas13 enzyme.

Anticipatory policy-making

Although scientists on the cusp of developing a way to make gene-editing technology safer, one of the main obstacles to the translation of CRISPR/Cas9 into clinically useful tools is the

possibility of off-target effects that can result in malignant transformation and other unforeseeable consequences.

There are concerns about the power and technical limitations of CRISPR technology, including the possibilities of limited on-target editing efficiency, incomplete editing, and the possible transfer of the edited genes to future generations, potentially affecting them in unexpected ways. Efficient targeted delivery of CRISPR technology in vivo, without significant on- or off-target toxicity, remains a challenge.

Given that there is a lack of a transition of CRISPR-based therapies from preclinical observations to proven and approved therapies, no approved CRISPR-based therapies are available and only a limited number of early clinical trials are ongoing. Given these uncertainties, questions arise about the potential for such products: how could they obtain regulatory approval even under fast-track procedures, if they cannot be properly tested in human clinical trials?

Who would be liable in the event that harmful side effects occur during the widespread use of a new medical countermeasure, such as a novel gene-editing technique during a pandemic emergency of this kind? One major concern with the use of CRISPR/Cas9 in the clinical setting relates to the potential risk that by lowering technical barriers the technology could be misused for biological weapon development.

More specifically, CRISPR could facilitate the editing of an existing pathogen to make it more damaging, edit a non-pathogenic organism to incorporate pathogen genes and traits, and even, theoretically, synthesize a novel pathogen.

Despite CRISPR's affordability, ease of use, and widespread availability, it remains ethically controversial and vulnerable to potential malicious misuse or even accidental mishap.

In view of these challenges and, as gene-editing technologies appear to be part of the international race to test coronavirus antiviral drugs and vaccines, the development of CRISPR-based diagnostics and of possible vaccines or therapies will require strong ethical oversight, strong evidence demonstrating a sufficient degree of safety and efficacy of such interventions, and the demonstration of the advantages of somatic gene editing over other antiviral strategies and standardized methods for safe treatment delivery.

Read the original article on European Parliament.