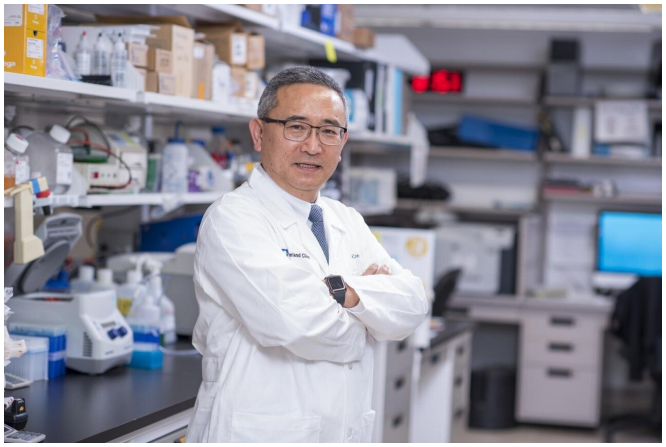
Nanoparticle-delivered COVID-19 vaccine candidate shows promise in preclinical studies

2 March 2021



Researchers from Cleveland Clinic's Global Center for Human Health & Pathogen Research have developed a promising new COVID-19 vaccine candidate. Credit: Cleveland Clinic

Researchers from Cleveland Clinic's Global Center for Pathogen Research & Human Health have developed a promising new COVID-19 vaccine candidate that utilizes nanotechnology and has shown strong efficacy in preclinical disease models.

According to new findings published in *mBio*, the vaccine produced potent neutralizing antibodies among preclinical models and also prevented infection and disease symptoms in the face of exposure to SARS-CoV-2 (the virus that causes COVID-19). An additional reason for the vaccine candidate's early appeal is that it may be thermostable, which would make it easier to transport and store than currently authorized COVID-19 vaccines.

"Our vaccine candidate delivers antigens to trigger an immune response via nanoparticles engineered from ferritin—a protein found in almost all living organisms," said Jae Jung, Ph.D., director of the Global Center for Human Health & Pathogen Research and co-senior author on the study. "This protein is an attractive biomaterial for vaccine and drug delivery for many reasons, including that it does not require strict temperature control."

Added Dokyun (Leo) Kim, a graduate student in Dr. Jung's lab and co-first author on the study, "This would dramatically ease shipping and storage constraints, which are challenges we're currently experiencing in national distribution efforts. It would also be beneficial for distribution to developing countries."

Other benefits of the protein nanoparticles include minimizing cellular damage and providing stronger immunity at lower doses than traditional protein subunit vaccines against other viruses, like influenza.

The team's vaccine uses the ferritin nanoparticles to deliver tiny, weakened fragments from the region of the SARS-CoV-2 spike protein that selectively binds to the human entry point for the virus (this fragment is called the receptor-binding domain, or RBD). When the SARS-CoV-2 RBD binds with the human protein called ACE2 (angiotensin-converting enzyme 2), the virus can enter host cells and begin to replicate.

The researchers tested their vaccine candidate on a ferret model of COVID-19, which reflects the human immune response and disease development better than other preclinical models. Dr. Jung, a foremost authority in virology and virus-induced cancers, previously developed the world's first COVID-19 ferret model—a discovery that has significantly advanced research into SARS-CoV-2 infection and transmission.

In this study, the researchers administered an initial dose of the vaccine candidate followed by two booster vaccines given 14 and 28 days later. One group received the vaccines intramuscularly, while another group received them both intramuscularly and intranasally.

After the second booster, all vaccinated models produced strong neutralizing antibodies. This suggests that repeated exposure to the RBD antigen successfully prepared the immune systems to rapidly fight the virus.

A few days after the second booster (31 days after the initial vaccine dose), the researchers exposed the models to high concentrations of SARS-CoV-2. Compared to the placebo group that received adjuvant-only vaccines (adjuvants are added ingredients that help vaccines work better), those that received the RBD-nanoparticle vaccine were better protected from clinical symptoms and lung damage associated with infection. The findings suggest the vaccine candidate helped prevent infection and serious disease.

Combination intramuscular and intranasal immunization showed more potent protective immunity and faster viral clearance than intramuscular immunization alone. Both were significantly more effective than the adjuvant-only vaccine. More research will be important to uncover the mechanisms behind these differential benefits.

While ferritin nanoparticles are well-characterized for their strong temperature and chemical stability, suggesting the RBD-nanoparticle vaccine may also be thermostable, future investigations will be necessary to validate. The researchers aim to confirm these findings in human clinical trials soon.

More information: Young-Il Kim et al, Development of Spike Receptor-Binding Domain Nanoparticles as a Vaccine Candidate against SARS-CoV-2 Infection in Ferrets, *mBio* (2021). DOI: 10.1128/mBio.00230-21

Provided by Cleveland Clinic
APA citation: Nanoparticle-delivered COVID-19 vaccine candidate shows promise in preclinical studies