Prevention of SARS-CoV-2 new infections may be the most effective approach, not only to prevent COVID-19 but also to block the spreading of the virus worldwide. Since SARS-CoV-2 virus was only recently identified, large efforts dedicated to vaccine development are being pursued. As of 30 June, 48 clinical trials are already evaluating the efficacy of COVID-19 vaccines (Supplementary Table 6a). One approach, developed by ModernaTX, Inc. uses lipid nanoparticles (LNP) encapsulating mRNA-1273 that encodes full-length, SARS-CoV-2 S protein (NCT04283461). Cells expressing this viral protein will be able to present T cell-recognized SARS-CoV-2 antigen and induce an immune response against the virus. This may be an effective and safe approach since it does not use viral particles, but rather delivers mRNA that can be expressed by immune cells and non-immune cells, leading to both MCH class I and MHC class II antigen presentation. Furthermore, encapsulating viral mRNA in LNP will protect the mRNA from degradation and enhance delivery efficiency[180]. ModernaTX's press release[181] published on 18 May announced the interim data of this ongoing phase I trial for mRNA-1273 vaccine, which indicate that the vaccine was generally well-tolerated and safe, and led to the production of neutralizing antibodies in eight initial patients enrolled in this study, two weeks after receiving the second dose of this COVID-19 vaccine candidate.

Recombinant novel CoV vaccine using adenovirus type 5 vector, also called Ad5-nCoV (NCT04313127) was proposed by Tianjin-based CanSino Biologics Inc. This product uses a genetically-modified adenovirus type 5 that is replication-defective and expresses the SARS-CoV-2 S protein. The ChAdOx1 nCoV-19 (NCT04324606) developed by the University of Oxford is also an adenovirus-vectored vaccine in clinical development, which has been explored as a vaccine against other infectious diseases, such as influenza, tuberculosis, Chikungunya virus (CHIKV), Zika, meningitis B and the plague.

There are other clinical trials exploring the use of genetically modified, activated immune cells, which recognize SARS-CoV-2 antigens (Supplementary Table 6a). Shenzhen Geno-Immune Medical Institute engineered minigenes (exon gene fragments) based on multiple viral genes, which are introduced into artificial antigen presenting cells (aAPC) using a lentiviral vector (NCT04299724). When injected into the