FINAL ESSAY - INTD 100
COVID 19 AND VACCINE DEVELOPMENT

Abstract

The COVID-19 pandemic has infected millions of people with no clear signs of abatement owing to the high prevalence, long incubation period and lack of established treatments or vaccines. Vaccines are the most promising solution to mitigate new viral strains. The genome sequence and protein structure of the COVID 19 were made available in record time, allowing the development of inactivated or attenuated viral vaccines along with subunit vaccines for prophylaxis and treatment. The current COVID-19 pandemic has urged the scientific community internationally to find answers in terms of therapeutics and vaccines to control SARS-CoV-2. Published investigations mostly on COVID and to some extent on MERS has taught lessons on vaccination strategies to this novel coronavirus. Here, is a review about COVID 19 and highlighting its vaccine development in detail.

Main

In December 2019, coronavirus belonging to the beta-coronavirus family emerged. All human beta-coronaviruses are unique from one another, however, they do share a certain degree of genetic and structural homology. SARS-CoV-2 genome sequence homology with SARS-CoV and MERS-CoV is 77% and 50%, respectively. In contrast to the relatively smaller outbreaks of SARS-CoV in 2002 and MERS-CoV in 2012, SARS-CoV-2 is exhibiting an unprecedented scale of infection, resulting in a global pandemic declaration of COVID-19 on 11 March 2020 by the World Health Organization (WHO). On 1 June 2020, the World Health Organization reported more than 6 million confirmed cases and 371 thousand deaths globally. Of note, during the 1918 influenza pandemic, more death was observed in the second phase of outbreak. Similar to influenza, COVID-19 harbours the potential to become a seasonal disease. The high infection rate, long incubation period, along with mild-to-moderate symptoms experienced by many, make COVID-19 a troubling disease. A vaccine is crucial, in particular because data indicate asymptomatic transmission of COVID-19. More than 10 years ago, scientists predicted the pandemic potential of the coronaviruses. And for the past 30 years, a once-per-decade novel coronavirus has pushed our public health system to the limit, with SARS-CoV-2 being the most severe. Despite the repeated warnings and discussion, the world was not prepared for this pandemic. The rapid development, distribution and administration of a vaccine to the global population is the most effective approach to quell this pandemic and the only one that will lead to a complete lifting of restrictions. Challenges include the vaccine design itself, but also its manufacture and global distribution; cold chain requirements present logistical and fiscal barriers to the availability of important, life-saving vaccines in resource-poor areas of the world. Innovating vaccine delivery platforms and devices to break cold chain limitations are therefore an efficient solution to safeguard potent vaccination for both wealthy and lower-income countries.

Development of the vaccination

SARS-CoV-2 is an enveloped ss-RNA virus with spike-like glycoproteins protruding from its exterior membrane surface forming a 'corona'. The four major structural proteins of beta-coronaviruses are spike protein, envelope protein, membrane protein, and nucleocapsid protein. The S protein is an attractive target for vaccine design because it facilitates viral entry into the host cell during the infection process. The two spike protein subdomains, S1 and S2, are responsible for host cell angiotensin-converting enzyme 2 receptor binding and host cell membrane fusion, respectively. S1 contains the receptor-binding domain (RBD) and S2 the fusion machinery enabling virus entry. While the S1 domain is divergent across the coronaviruses, the S2 domain is more conserved. Combining SARS-CoV-2 structural information and knowledge gained from SARS/MERS vaccine candidates, researchers projected the full length S protein, as well as S1, RBD, and S2 subunit derivatives, to contain the prime target epitopes for the induction of neutralizing antibodies. Indeed, recent clinical data has indicated several strategies to develop the vaccine. The vaccines have been categorized under two heads namely contemporary and ones developed using nanotechnology.

Contemporary vaccines-

Contemporary vaccines(CVs) are live, reproducing but avirulent viruses. Its design intends single-dose immunity without illness. Because the technology is mature, they are likely to emerge as one of the frontrunner vaccine candidates for the ongoing COVID-19 pandemic. Codagenix Incorporation's proprietary deoptimized SARS-CoV-2 vaccine candidate currently leads the charge. However, CVs bear risks of transfer of the virus and/or reversion to the pathogenic form, reactivation in immune-compromised individuals or recombination with related viruses circulating in the population—especially for novel diseases where pathophysiology is not yet fully understood. CVs generally require cold chain distribution. Furthermore, loss of efficacy and reproductive potential of progeny viruses during vaccine production poses a significant challenge. Preliminary studies of silent codon change indicate some positive effect on mitigating reversion events, however, these are not general to all viruses. New technologies such as genetic code expansion are being applied to create highly reproductive but genetically stable CVs. More recently, synthetic genomics approaches have enabled the synthesis of recombinant SARS-CoV-2 viruses from fragments of viral DNAs. These strategies could be employed towards rapid generation of SARS-CoV-2 CVs.

Vaccines developed using nanotechnology-

Viruses are nanoscale objects and therefore can be regarded as naturally occurring nanomaterials; per that definition, LAVs, IVs and viral vectors are nanotechnologies. Nanoparticles and viruses operate at the same length scale—this is what makes nanotechnology approaches in vaccine development and immune-engineering so powerful. Nanoparticles, natural or synthetic, mimic the structural features of viruses whereas chemical biology, biotechnology and nano-chemistry enables the development of next-generation designer vaccine technologies. From a vaccine technology development point of view, this is an exciting time and novel technologies and approaches are poised to make a clinical impact for the first time.

Conclusion

As devastating as COVID-19 is, it may serve as an impetus for the scientific community, funding bodies, and stakeholders to commit more focused efforts toward development of platform technologies that bolster the preparedness for future pandemics. Indeed, COVID-19 harbours the potential to become a seasonal disease; underscoring the need for continued investment in coronavirus vaccines. SARS and MERS vaccine candidates did not make it to market due to lack of financial incentive given the low infection numbers, and because the risk of a global pandemic from a newly emerged virus were largely ignored. Yet, because there is some conservation between the coronaviruses, continued research and product development is critical to tackle any new version of coronavirus that emerges in the future.

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