2021

The COVID-19 Vaccine Development Landscape

Areebah Ahmed
Virginia Commonwealth University

COVID-19 VACCINE DEVELOPMENT

Areebah Ahmed

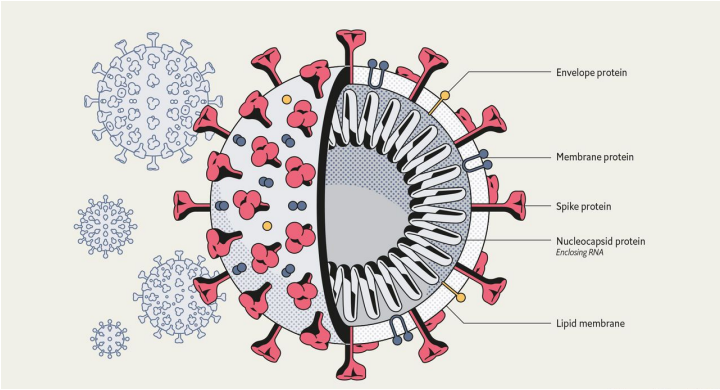
Article Name:

The COVID-19 Vaccine Development Landscape

Tung Thanh Le et. al

COVID-19

- January 11, 2020
  - Publication of the genetic sequence of SARS-CoV-2
    - Led to the rapid development of vaccine for the virus
- About two months later...
  - March 16, 2020
    - The first COVID-19 vaccine began human clinical trials



The Coalition for Epidemic Preparedness Innovations (CEPI)

- Headquarters in Oslo, Norway
- A global coalition consisting of public, private, and philanthropic organizations
- Support and fund acceleration of vaccine development during epidemic diseases

April 8, 2020

- **COVID-19 VACCINES**
  - **115** Vaccine Candidates
    - **78** are confirmed and active
      - **73** of which are currently in preclinical or exploratory stages
    - **37** unconfirmed
    - Many vaccine developers plan for human testing trials in 2020

- **Current Vaccines in Clinical Development**
  - Moderna: mRNA-1273
    - Began clinical testing 2 months after sequence identification
  - CanSino Biologicals: Ad5-nCoV
  - Inovio: INO-4800
  - Shenzhen Geno-Immune Medical Institute: LV-SMENP-DC and pathogen-specific aAPC

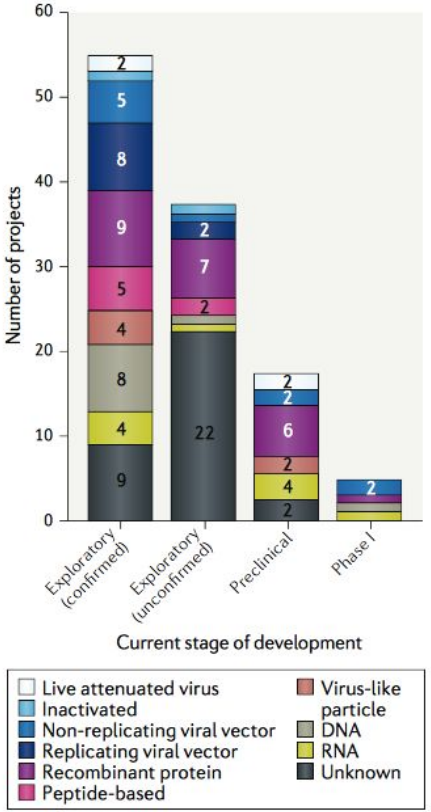
Table 1 | **Clinical-phase vaccine candidates for COVID-19**

Candidate	Vaccine characteristics	Lead developer	Status
mRNA-1273	LNP-encapsulated mRNA vaccine encoding S protein	Moderna	Phase I (NCT04283461)
Ad5-nCoV	Adenovirus type 5 vector that expresses S protein	CanSino Biologicals	Phase I (NCT04313127)
INO-4800	DNA plasmid encoding S protein delivered by electroporation	Inovio Pharmaceuticals	Phase I (NCT04336410)
LV-SMENP-DC	DCs modified with lentiviral vector expressing synthetic minigene based on domains of selected viral proteins; administered with antigen-specific CTLs	Shenzhen Geno-Immune Medical Institute	Phase I (NCT04276896)
Pathogen-specific aAPC	aAPCs modified with lentiviral vector expressing synthetic minigene based on domains of selected viral proteins	Shenzhen Geno-Immune Medical Institute	Phase I (NCT04299724)

aAPC, artificial antigen-presenting cell; CTL, cytotoxic T lymphocyte; DC, dendritic cell; LNP, lipid nanoparticle; S protein, SARS-CoV-2 spike protein. Source: ClinicalTrials.gov website; WHO.

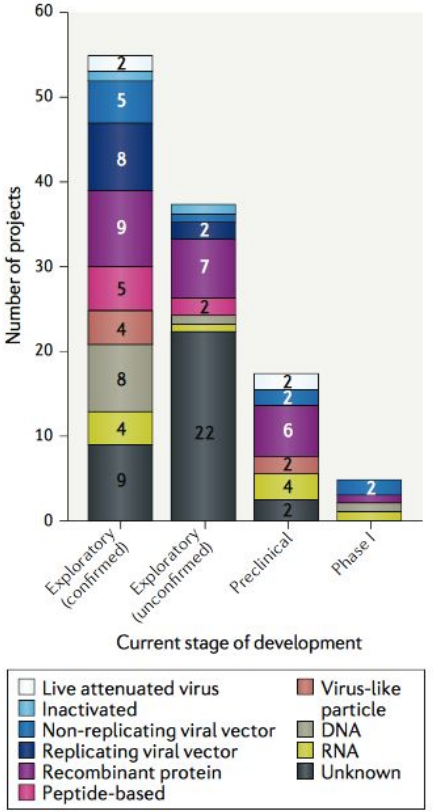
Diversity in Vaccine Development Platforms

- **Technology platforms include…**
  - Nucleic Acid (DNA/RNA)
  - Virus-Like Particle
  - Peptide
  - Viral Vector (replicating and non-replicating)
  - Recombinant Protein
  - Live attenuated virus and inactivated virus approaches
- It is possible that some vaccines may be most effectiv with specific populations such as elderly, pregnant women, and children



Analysis of Current Vaccine Platforms

- Vaccines focused on DNA or mRNA
  - offers promising versatility of antigen manipulation & speed
- Vaccines based on Viral Vectors
  - long-term stability, high level of protein expression, and induces strong immune responses
- Vaccines based on Recombinant Proteins
  - Previously licensed vaccines for other diseases
  - **Pro**: ability for large scale production due to the existing vaccines



Adjuvants

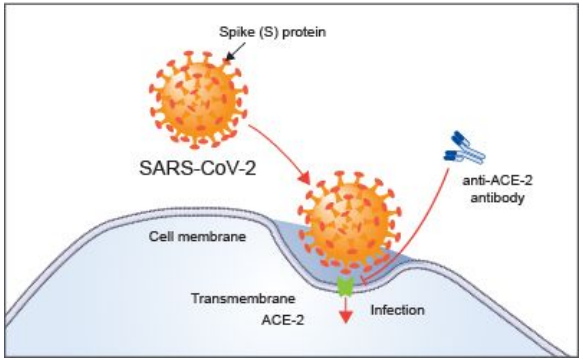
Definition: substances that may be added to a vaccine in order to produce a strong immune response to the vaccine

- **Pros**: potential for lower viable doses & enhance immunogenicity

- GlaxoSmithKline, Seqirus, Dynavax

Specifics in SARS-CoV-2 Vaccine Development

- Information about the specific antigens being used in vaccine development is limited
  - Available information describes the induction of neutralizing antibodies against the viral spike (S) protein, preventing uptake via the human ACE2 receptor
- Current research has not yet determined how the S protein relates to its various other forms and COVID-19



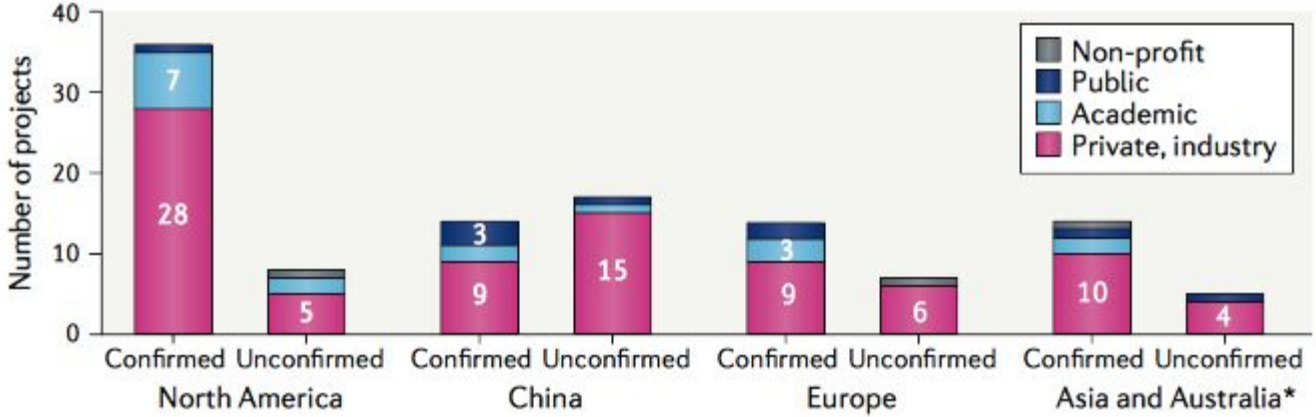


Fig. 2 | **Profile of COVID-19 vaccine developers by type and geographic location.** For partnerships, the location is that of the lead developer. *Excluding China.

72% - private/industry developers

28% - academic, public sector, and other non-profit organizations

46% - developers in North America

18% - China

18% - Asia (excluding China)

18% - Europe

Conclusion

- Possible vaccines may be available by early 2021
  - Emergency use ONLY
- Average vaccine development usually takes around 10 years
  - Ebola Virus : 5 year development of a vaccine
- Development of COVID-19 Specific Animal Models
  - ACE2-transgenic mice
  - Hamsters
  - ferrets
  - non-human primates

Discussion Questions

- Is it more likely for developers in another country, such as China, to finalize a vaccine before the US?
- How do you think the current lack of a vaccine will affect the rate of the spread of the virus?

Citation

Thanh Le, T., Andreadakis, Z., Kumar, A., Gómez Román, R., Tollefsen, S., Saville, M., & Mayhew, S. (2020). The COVID-19 vaccine development landscape. *Nature reviews. Drug discovery*, *19*(5), 305–306. https://doi.org/10.1038/d41573-020-00073-5