



The Science Of Saving Lives: Understanding Covid-19 Vaccines

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Abstract

The COVID-19 pandemic has affected the world since its emergence in 2019, causing unprecedented social and economic disruptions. The development of vaccines has been a crucial part of the global response to the pandemic. Several COVID-19 vaccines have been authorized for emergency use, and millions of doses have been administered worldwide. The vaccines have demonstrated high efficacy in preventing severe disease, hospitalization, and death caused by COVID-19, and have played a significant role in reducing the transmission of the virus. Despite their success, challenges remain in ensuring equitable distribution and uptake of vaccines globally, and in addressing concerns about vaccine safety and efficacy. Ongoing research and collaboration are necessary to further understand the long-term effectiveness of COVID-19 vaccines and to continue refining the global vaccination strategy to ultimately control the spread of the virus.

Keywords: COVID-19, Global, Pandemic, Vaccination, Virus.

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INTRODUCTION:

Covid-19

Covid-19, also known as the novel coronavirus, is a highly contagious respiratory illness caused by the SARS-CoV-2 virus. The virus was first identified in Wuhan, China, in December 2019, and quickly spread to become a global pandemic ^[1]. Since then, it has affected millions of people worldwide, with many experiencing severe illness and, sadly, loss of life ^[2]. The pandemic has had a significant impact on the global economy, with businesses, industries, and individuals suffering financial losses ^[3]. Governments around the world have implemented strict measures such as lockdowns, social distancing, and mandatory masks to prevent the spread of the virus ^[4]. While these measures have helped to slow the spread of the virus, they have also led to many job losses and economic hardships for people.

The development of vaccines has provided hope in the fight against the pandemic, and several countries have launched vaccination campaigns. However, the emergence of new variants of the virus has led to concerns about vaccine efficacy and the potential for ongoing outbreaks ^[5]. Overall, the Covid-19 pandemic has had a profound impact on the world, and its effects are likely to be felt for many years to come ^[6]. It has highlighted the importance of global cooperation, preparedness, and investment in public health systems to prevent and control the spread of infectious diseases ^[7]. Research on COVID-19 is ongoing, including studies on treatments, vaccines, long-term effects, and the dynamics of the virus. Scientists and health experts continue to monitor the situation and provide updated guidance on how to manage the pandemic. It's important to note that information about COVID-19 is constantly evolving, and it's recommended to refer to reliable sources for the latest updates and guidance on this topic ^[6].

The COVID-19 pandemic has caused an unprecedented global health crisis, with over 475 million cases and more than 6 million deaths reported worldwide as of November 2021 ^[8]. The development of safe and effective vaccines against COVID-19 has been a critical

priority for governments, health organizations, and the scientific community ^{[9][10]}. In this review, we discuss the COVID-19 vaccines and their immunization strategies ^[10].

Vaccine

A vaccine is a biological preparation that enhances the body's immune response to fight against specific infections or diseases. It contains a small, weakened or dead portion of the disease-causing microorganism, or a part of it, that stimulates the immune system to produce antibodies that recognize and destroy the pathogen ^[11]. Vaccines are essential in preventing and controlling the spread of infectious diseases. Vaccines work by mimicking the natural infection process, without causing the disease itself. The immune system is activated when it detects foreign substances or antigens present in the vaccine. The body then produces antibodies that target the specific antigen and protect against the pathogen. The immune system also creates memory cells that remember the antigen and provide long-lasting protection against future infections ^[12].

Vaccines have been responsible for the eradication or near-elimination of many infectious diseases that once caused significant morbidity and mortality worldwide. For example, smallpox was declared eradicated in 1980, thanks to widespread vaccination efforts. Polio, measles, rubella, and tetanus are other diseases that have been largely controlled through vaccination. Vaccines can be administered through various routes, including injection, oral, nasal, or intradermal routes ^[13]. The most common way to administer vaccines is through injection, either subcutaneously or intramuscularly. Some vaccines require booster doses to maintain immunity over time, while others provide lifelong protection after a single dose ^[14].

Vaccines are rigorously tested for safety and efficacy before being approved for use in humans. Clinical trials involve several phases, including preclinical testing in animals, phase I trials in a small number of human volunteers to assess safety, phase II trials in a larger group to evaluate safety and immunogenicity, and

phase III trials in thousands of people to assess safety and effectiveness [15]. In addition to protecting individuals from disease, vaccines also play a crucial role in preventing the spread of infectious diseases within communities. This is achieved through herd immunity, which occurs when a large portion of the population is immune to a disease, making it difficult for the pathogen to spread. Herd immunity protects individuals who are unable to receive vaccines, such as those with certain medical conditions or allergies [16].

Vaccines are a crucial tool in the fight against infectious diseases. They have proven to be safe and effective in preventing and controlling many diseases that were once a significant threat to public health. Vaccines provide individual protection as well as herd immunity, which is essential in preventing outbreaks and reducing the burden of disease in communities [17]. Vaccination campaigns have been launched worldwide to control the spread of COVID-19. Vaccines have shown to be effective in reducing the severity of illness, hospitalizations, and deaths associated with COVID-19. Many countries have implemented public health measures such as lockdowns, travel restrictions, and mask mandates to slow the spread of the virus and protect public health [16].

COVID-19 Vaccines:

Several COVID-19 vaccines have been authorized for emergency use by regulatory agencies worldwide. The vaccines use different technologies to generate an immune response against the SARS-CoV-2 virus that causes COVID-19 [18]. These include:

mRNA vaccines:

Pfizer-BioNTech and Moderna vaccines use a novel technology that delivers messenger RNA (mRNA) to cells, instructing them to produce a harmless piece of the spike protein found on the surface of the SARS-CoV-2 virus [19]. The immune system recognizes the spike protein as foreign and generates an immune response against it [20][21].

Viral vector vaccines:

Oxford-AstraZeneca and Johnson & Johnson vaccines use a weakened version of a common cold virus (adenovirus) that has been modified to carry the genetic material for the SARS-CoV-2 spike protein [22][23]. The viral vector delivers the genetic material to cells, instructing them to produce the spike protein and trigger an immune response [24].

Protein subunit vaccines:

Novavax vaccine uses a small piece of the SARS-CoV-2 spike protein to generate an immune response. The protein subunit is produced using insect cells grown in a laboratory [25][26].

Immunization Strategies:

The immunization strategies for COVID-19 vaccines aim to provide widespread protection against the SARS-CoV-2 virus [27]. These include:

Mass vaccination campaigns:

Governments worldwide have initiated mass vaccination campaigns, targeting priority groups such as healthcare workers, elderly, and people with underlying medical conditions. These campaigns have been successful in reaching a large proportion of the population and reducing the incidence of COVID-19 [28][29].

Booster doses:

Some countries have initiated booster dose campaigns to maintain the immunity levels in the population, particularly against the emerging variants of SARS-CoV-2 [30]. The booster doses are being recommended for individuals who have received the primary vaccination series [31].










Global vaccine equity:

The World Health Organization and other health organizations have emphasized the importance of global vaccine equity to ensure that all countries have access to COVID-19 vaccines [32]. The COVAX initiative aims to provide vaccines to low- and middle-income countries to reduce the burden of COVID-19 [33].

There are currently several COVID-19 vaccines that have been authorized for emergency use or fully approved by various

regulatory agencies around the world [34]. Here is a list of some of the most commonly used vaccines were tabulated in Table 1.

Table 1: list of some of the most commonly used vaccines

S. No	Vaccine	Brand
1	Pfizer-BioNTech vaccine [35]	
2	Moderna vaccine [36]	
3	Johnson & Johnson's Janssen vaccine [37]	
4	AstraZeneca vaccine (also known as Vaxzevria or Covishield depending on the manufacturer and country) [38]	
5	Sinovac vaccine [39]	
6	Sinopharm vaccine [40]	
7	Novavax vaccine [41]	
8	Covovax vaccine (developed by Novavax in collaboration with Serum Institute of India) [42]	
9	Sputnik V vaccine [43]	

CONCLUSION:

COVID-19 vaccines have played a crucial role in reducing the impact of the pandemic, particularly in high-income countries. The vaccines have demonstrated high efficacy and safety in clinical trials and real-world settings. However, challenges remain in ensuring global vaccine equity and addressing vaccine hesitancy [44]. Continued efforts are needed to develop new vaccines, optimize immunization strategies, and monitor the long-term safety and effectiveness of COVID-19 vaccines. The development of COVID-19 vaccines has been a remarkable scientific achievement, with unprecedented collaboration between governments, pharmaceutical companies, research institutions, and healthcare organizations [45]. These vaccines have

undergone rigorous testing in clinical trials to ensure their safety and efficacy. They utilize various mechanisms, including mRNA, vector, and protein-based technologies, to stimulate the immune system to recognize and fight the virus. The vaccines have shown high efficacy rates in preventing COVID-19 infection, and real-world data has demonstrated their ability to reduce hospitalizations and deaths from the disease [46].

COVID-19 is primarily transmitted through respiratory droplets when an infected person coughs or sneezes, but it can also spread through close contact with infected individuals or by touching contaminated surfaces [45].

The rapid deployment of COVID-19 vaccines has faced challenges, including issues related to vaccine distribution, access, equity, and vaccine hesitancy. There have been concerns about vaccine safety, potential side effects, and the speed of vaccine development, leading to misinformation and hesitancy among some populations^[47]. Equity in vaccine distribution has been a concern, with disparities in access among different regions and communities. However, efforts have been made to address these issues, including vaccine donations to low-income countries, education campaigns to address misinformation, and outreach efforts to underserved communities^[48].

In conclusion, COVID-19 vaccines have played a crucial role in controlling the spread of the virus and mitigating its impact on public health and the global economy. They represent a significant scientific achievement and a testament to the power of collaboration and innovation in times of crisis. Vaccination campaigns have saved lives and brought hope for a return to normalcy^[49].

However, challenges related to vaccine distribution, access, equity, and hesitancy need to be continuously addressed to ensure that as many people as possible can benefit from the protection offered by COVID-19 vaccines. Continued research, monitoring of safety and efficacy, and ongoing efforts to build trust and address concerns will be critical as the world continues to navigate the challenges of the COVID-19 pandemic^[50].

REFERENCES

1. Ciotti M, Ciccozzi M, Terrinoni A, Jiang WC, Wang CB, Bernardini S. The COVID-19 pandemic. *Critical reviews in clinical laboratory sciences*. 2020 Aug 17;57(6):365-88.
2. Yang L, Liu S, Liu J, Zhang Z, Wan X, Huang B, Chen Y, Zhang Y. COVID-19: immunopathogenesis and Immunotherapeutics. *Signal transduction and targeted therapy*. 2020 Jul 25;5(1):128.
3. World Health Organization. Coronavirus disease (COVID-19), 12 October 2020.
4. Pokhrel P, Hu C, Mao H. Detecting the coronavirus (COVID-19). *ACS sensors*. 2020 Jul 6;5(8):2283-96.
5. Zhao J, Zhao S, Ou J, Zhang J, Lan W, Guan W, Wu X, Yan Y, Zhao W, Wu J, Chodosh J. COVID-19: coronavirus vaccine development updates. *Frontiers in immunology*. 2020 Dec 23;11:602256.
6. Park JW, Lagniton PN, Liu Y, Xu RH. mRNA vaccines for COVID-19: what, why and how. *International journal of biological sciences*. 2021;17(6):1446.
7. Lv H, Wu NC, Mok CK. COVID-19 vaccines: knowing the unknown. *European journal of immunology*. 2020 Jul;50 (7):939-43.
8. Yang L, Tian D, Liu W. Strategies for vaccine development of COVID-19. *Sheng wu Gong Cheng xue bao= Chinese Journal of Biotechnology*. 2020 Apr 1;36(4):593-604.
9. Shahcheraghi SH, Ayatollahi J, Aljabali AA, Shastri MD, Shukla SD, Chellappan DK, Jha NK, Anand K, Katari NK, Mehta M, Satija S. An overview of vaccine development for COVID-19. *Therapeutic delivery*. 2021 Mar;12(3):235-44.
10. Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *Journal of public health*. 2021 Sep;43(3):445-9.
11. Roth GA, Picece VC, Ou BS, Luo W, Pulendran B, Appel EA. Designing spatial and temporal control of vaccine responses. *Nature Reviews Materials*. 2022 Mar;7(3):174-95.
12. Hogan B, Beddington R, Costantini F, Lacy F, Silver LM. Vaccine cornucopia. *EMBO Reports*. 2000;1(5):379.
13. Brisse M, Vrba SM, Kirk N, Liang Y, Ly H. Emerging concepts and technologies in vaccine development. *Frontiers in immunology*. 2020 Sep 30;11:583077.
14. Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. *the Lancet*. 2011 Aug 6;378(9790):526-35.
15. Conis E. *Vaccine nation: America's changing relationship with immunization*. University of Chicago Press; 2014 Oct 20.
16. Coustasse A, Kimble C, Maxik K. COVID-19 and vaccine hesitancy: a

- challenge the United States must overcome. *The Journal of ambulatory care management*. 2021 Jan 1;44(1):71-5.
17. Han S. Clinical vaccine development. *Clinical and experimental vaccine research*. 2015 Jan 1;4(1):46-53.
 18. Ndwandwe D, Wiysonge CS. COVID-19 vaccines. *Current opinion in immunology*. 2021 Aug 1;71:111-6.
 19. Pardi N, Hogan MJ, Porter FW, Weissman D. mRNA vaccines—a new era in vaccinology. *Nature reviews Drug discovery*. 2018 Apr;17(4):261-79.
 20. Park JW, Lagniton PN, Liu Y, Xu RH. mRNA vaccines for COVID-19: what, why and how. *International journal of biological sciences*. 2021;17(6):1446.
 21. Dolgin E. The tangled history of mRNA vaccines. *Nature*. 2021 Sep 1;597(7876):318-24.
 22. McCann N, O'Connor D, Lambe T, Pollard AJ. Viral vector vaccines. *Current Opinion in Immunology*. 2022 Aug 1;77:102210.
 23. Liniger M, Zuniga A, Naim HY. Use of viral vectors for the development of vaccines. *Expert review of vaccines*. 2007 Apr 1;6(2):255-66.
 24. Travieso T, Li J, Mahesh S, Mello JD, Blasi M. The use of viral vectors in vaccine development. *npj Vaccines*. 2022 Jul 4;7(1):75.
 25. Heidary M, Kaviar VH, Shirani M, Ghanavati R, Motahar M, Sholeh M, Ghahramanpour H, Khoshnood S. A comprehensive review of the protein subunit vaccines against COVID-19. *Frontiers in microbiology*. 2022 Jul 14;13:927306.
 26. Hansson M, Nygren PA, Stahl S. Design and production of recombinant subunit vaccines. *Biotechnology and applied biochemistry*. 2000 Oct;32(2):95-107.
 27. Chen Y, Paul G, Havlin S, Liljeros F, Stanley HE. Finding a better immunization strategy. *Physical review letters*. 2008 Jul 31;101(5):058701.
 28. Heymann DL, Aylward RB. Mass vaccination: when and why. *Mass Vaccination: Global Aspects—Progress and Obstacles*. 2006:1-6.
 29. Belsare AV, Gompper ME. Assessing demographic and epidemiologic parameters of rural dog populations in India during mass vaccination campaigns. *Preventive Veterinary Medicine*. 2013 Aug 1;111(1-2):139-46.
 30. Chenchula S, Karunakaran P, Sharma S, Chavan M. Current evidence on efficacy of COVID-19 booster dose vaccination against the Omicron variant: A systematic review. *Journal of Medical Virology*. 2022 Jul;94(7):2969-76.
 31. Abdelmoneim SA, Sallam M, Hafez DM, Elrewany E, Mousli HM, Hammad EM, Elkhadry SW, Adam MF, Ghobashy AA, Naguib M, Nour El-Deen AE. COVID-19 vaccine booster dose acceptance: Systematic review and meta-analysis. *Tropical Medicine and Infectious Disease*. 2022 Oct 13;7(10):298.
 32. Jecker NS. Focus: Vaccines: Achieving Global Vaccine Equity: The Case for an International Pandemic Treaty. *The Yale Journal of Biology and Medicine*. 2022 Jun;95(2):271.
 33. Kalafat E, Magee LA, von Dadelszen P, Heath P, Khalil A. COVID-19 booster doses in pregnancy and global vaccine equity. *Lancet (London, England)*. 2022 Mar 5;399(10328):907.
 34. Van Riel D, de Wit E. Next-generation vaccine platforms for COVID-19. *Nature materials*. 2020 Aug;19(8):810-2.
 35. Oliver SE, Gargano JW, Marin M, Wallace M, Curran KG, Chamberland M, McClung N, Campos-Outcalt D, Morgan RL, Mbaeyi S, Romero JR. The advisory committee on immunization practices' interim recommendation for use of Pfizer-BioNTech COVID-19 vaccine—United States, December 2020. *Morbidity and mortality weekly report*. 2020 Dec 12;69(50):1922.
 36. Mahase E. Covid-19: Moderna vaccine is nearly 95% effective, trial involving high risk and elderly people shows. *BMJ: British Medical Journal (Online)*. 2020 Nov 17;371.
 37. Jhawar N, Joundi H, Gonzalez-Estrada A. Successful graded-dose challenge of the Janssen vaccine against SARS-CoV-2 in a high-risk patient. *QJM: An International*

- Journal of Medicine. 2022 May;115(5):329-30.
38. Oldenburg J, Klamroth R, Langer F, Albisetti M, Von Auer C, Ay C, Korte W, Scharf RE, Pöttsch B, Greinacher A. Diagnosis and management of vaccine-related thrombosis following AstraZeneca COVID-19 vaccination: guidance statement from the GTH. *Hämostaseologie*. 2021 Jun;41(03):184-9.
 39. Heriyanto RS, Kurniawan A, Wijovi F, Halim DA, Jodhinata C, Marcella E, Susanto B, Wibowo J, Indrawan M, Heryadi NK, Imanuelly M. The role of COVID-19 survivor status and gender towards neutralizing antibody titers 1, 2, 3 months after Sinovac vaccine administration on clinical-year medical students in Indonesia. *International Journal of Infectious Diseases*. 2021 Dec 1;113:336-8.
 40. Ahamed F, Ganesan S, James A, Zaher WA. Understanding perception and acceptance of Sinopharm vaccine and vaccination against COVID-19 in the UAE. *BMC public health*. 2021 Dec;21:1-1.
 41. Callaway E, Mallapaty S. Novavax Covid vaccine protects people against variants. *Nature*. 2021 Feb 4;590(17):10-38.
 42. Ranade D, Jena R, Patil K, Dogar V, Sancheti S, Deore V, Ashtagi S, Gairola S. A novel high throughput plate-based method for 2-PE quantification in novel multidose vaccines (R21 malaria, Covishield and Covovax) and combination vaccines (Hexavalent). *Vaccine*. 2023 Mar 17;41(12):1979-88.
 43. Cazzola M, Rogliani P, Mazzeo F, Matera MG. Controversy surrounding the Sputnik V vaccine. *Respiratory medicine*. 2021 Oct 1;187:106569.
 44. Le TT, Andreadakis Z, Kumar A, Román RG, Tollefsen S, Saville M, Mayhew S. The COVID-19 vaccine development landscape. *Nat Rev Drug Discov*. 2020 May 1; 19(5):305-6.
 45. Le TT, Cramer JP, Chen R, Mayhew S. Evolution of the COVID-19 vaccine development landscape. *Nat Rev Drug Discov*. 2020 Oct 1; 19(10):667-8.
 46. Haque A, Pant AB. Efforts at COVID-19 vaccine development: challenges and successes. *Vaccines*. 2020 Dec 6; 8(4): 739.
 47. Heaton PM. The Covid-19 vaccine-development multiverse. *New England Journal of Medicine*. 2020 Nov 12; 383 (20):1986-8.
 48. Bok K, Sitar S, Graham BS, Mascola JR. Accelerated COVID-19 vaccine development: milestones, lessons, and prospects. *Immunity*. 2021 Aug 10; 54(8):1636-51.
 49. Kumar A, Dowling WE, Román RG, Chaudhari A, Gurry C, Le TT, Tollefsen S, Clark CE, Bernasconi V, Kristiansen PA. Status report on COVID-19 vaccines development. *Current Infectious Disease Reports*. 2021 Jun;23:1-2.
 50. Strizova Z, Smetanova J, Bartunkova J, Milota T. Principles and challenges in anti-COVID-19 vaccine development. *International Archives of Allergy and Immunology*. 2021; 182(4):339-49.
 51. Ndwandwe D, Wiysonge CS. COVID-19 vaccines. *Current opinion in immunology*. 2021 Aug 1;71:111-6.