Editorial

COVID-19 Vaccines Help with Herd Immunity

Usa Lek-Uthai, Dr.P.H.

Keywords:
SARS-CoV-2, Covid-19 vaccine, Efficacy, Effectiveness, Natural immunity

Coronavirus Disease (COVID-19)

Coronavirus 2019 (COVID-19) is an infectious disease caused by a newly discovered coronavirus, SARS-CoV-2, which is a single-stranded RNA virus. Considered to be a global pandemic, COVID-19 is highly transmissible. COVID-19 can be transmitted via direct contact with saliva, nasal discharge and sputum. It could also spread if people touch an object or surface with virus present from an infected person and then touch their mouth, nose or eyes. COVID-19 cases continue to rise and people around the world have placed their hopes on a vaccine to overcome this crisis. Many countries are developing vaccines against COVID-19 according to the mutated virus. More than 100 types of vaccines must go through research studies and production approval both in animal studies and in humans[1-3].

COVID-19 Vaccines

More reports have been coming out about the effectiveness of the vaccines that are in use and the potential of those still in development. A number of vaccines with different manufacturers have been continuously developed and launched. A comparison of the most prominent COVID-19 vaccines have been performed. Vaccines from Pfizer-BioNTech, Moderna, Johnson and Johnson, Astra Zeneca, Sinovac, and Sinopharm are being administered, developed and/or researched. All of them intend to achieve immunity to the virus by stimulating an immune response to an antigen which is the spike glycoprotein protruding on the surface of the virus. The spike glycoprotein plays an essential role in virus attachment, fusion and entry into the human cell. This spike glycoprotein specifically binds with host cell receptors in the respiratory tract or digestive tract. After entering the body, viruses start invading and causing disease afterwards. There are four types of coronavirus vaccine[4-10], as follows:

1. Genetic vaccines including mRNA use a new technology to synthesize viral messenger RNA (mRNA) which is produced from the genetic material of the virus that causes COVID-19 or SARS-CoV-2 when injected into the human body. Vaccines carry mRNA into cells and direct the cells to produce viral spike proteins. This protein stimulates the body's immune system to produce antibodies against the infection. Currently available vaccines include the Pfizer-BioNTech and Moderna vaccines. The Pfizer-BioNTech vaccine is approximately 95% effective in preventing disease, preventing severe illness and preventing a high percentage, or 100%, of deaths. Two injections of Pfizer-BioNTech vaccine should be administered intramuscularly, three weeks apart, while Moderna's vaccine should be administered intramuscularly, four weeks apart. Vaccines in this group also need to be stored at -70 or -20 degrees Celsius, in order to remain effective. Pfizer-BioNTech also sought, and is planned, to start clinical trials back in August 2021, to test a booster shot against the highly contagious Delta variant, which was first spotted in India in

October 2020. Experts noted gene mutations in COVID-19 cases in people in many countries, which were later named the Alpha, Beta, Gamma and Delta variants. At the time of writing, the Delta variant had been found in more than 130 countries. The common side effects of the vaccinations, such as chills, headache, pain, tiredness, and/or redness and swelling at the injection site, generally resolve within a day or two of rest, hydration, and medications. For that reason, after a COVID-19 shot, a person must be observed for 30 minutes. The Moderna vaccine is also an mRNA vaccine, which can be shipped and kept in long-term storage in standard freezer temperatures, and stored for up to 30 days using normal refrigeration, thereby making it easier to distribute and store[4-9].

2. Recombinant viral vector vaccine uses genetically-modified viruses, such as the Adenovirus, which cannot divide and carry the genetic material of the COVID-19 virus. These vectors mimic natural infections by stimulating the immune system to make antibodies against the COVID-19 virus. Currently, this vaccine is widely used. Chimpanzee adenovirus, which is about 70-80% effective in preventing a high percentage, or 100%, of deaths. The vaccine is AstraZeneca's vaccine in collaboration with the University of Oxford, U.K. The Thai government received production technology for this vaccine from Oxford University, and the first batch of 26 million doses were delivered to Thailand in May 2021. The overall average efficacy of the vaccine was 70% in subjects who received half a dose followed by one dose, and 90% in the subjects who received two doses. The efficacy of the vaccine was 62% with two doses, four weeks apart, intramuscularly. The vaccine can be stored at a temperature of 2-8 degrees Celsius, for at least six months. As for the side effects, no serious symptoms were found to be related to vaccination. The common side effects were tenderness, pain, warmth, redness, itching, swelling or bruising at the injection site, all of which generally resolve within a day or two[6-8,10-11].

3. Protein subunit vaccine is a protein-based vaccine, which is a vaccine containing SARS-CoV-2 protein. When injected into the body, it stimulates the body to produce antibodies against the spike protein of the COVID-19 virus. The vaccine currently available is the Novavax vaccine, which is made from the baculovirus and uses Matrix M as an immune booster. This vaccine has been shown to be effective not only against COVID-19, but also against the mutations that have emerged in the U.K. and, to a lesser extent, South Africa. Novavax, which is currently in Phase 3 human research trials is 90% effective as of June 2021. It is called a protein adjuvant, which is an ingredient used to strengthen immune response. It is also simpler to make and can be stored in a refrigerator. The common side effects were injection site tenderness, fatigue, headache, and muscle pain unlike the mRNA and vector vaccines. The Novavax vaccine takes a different approach, it contains the spike protein of the coronavirus itself, but is formulated as a nanoparticle, which cannot cause disease. When the vaccine is injected, this stimulates the immune system to produce antibodies and T-cell immune responses. More data is needed to determine the effectiveness of Novavax against the Delta variant[6-8,10].

4. Inactivated vaccine is produced by using the inactivated SARS-CoV-2 virus. These vaccines put a weakened or inactivated disease germ into the body. Vaccination stimulates the body to build immunity against all parts of the virus. The CoronaVac vaccine is owned by Sinovac, China. However, the price of the vaccine may be quite high because the manufacturing process must be carried out in a laboratory with a Level 3 biosafety system for vaccine efficacy, as culturing the virus requires extreme caution. The Sinovac vaccine is 50-70% effective, and prevents a high percentage, or 100%, of deaths in some variants at present[6-8,10].

The Faculty of Medicine, Chulalongkorn University, announced the first human trial of the "ChulaCov19" vaccination. The vaccine has undergone Phase I trials and continued to Phase 2 screening in humans, to determine the immune response to the ChulaCov19 vaccine under the supervision of a team of specialist research teams[12].

The COVID-19 vaccines that are being used in Thailand (Sinovac and AstraZeneca) have been registered and approved by the Food and Drug Administration (FDA) in accordance with the standards. Sinovac was imported into Thailand for the first time in February 2021 (200,000 doses) and in March 2021 (800,000 doses) from a total of 2 million doses ordered, according to the statement from the Thai government. However, the U.S. government donated 1 million doses of the Pfizer vaccine to the Thai government in August 2021, on top of 1.5 million doses that it had previously donated. Thailand will order and receive an additional 20 million doses of the Pfizer COVID-19 vaccine later this year, but also plans to order a further 10 million shots from the company.

Natural Immunity

Natural immunity (i.e. immunity in people who have been infected with COVID-19) can last for up to eight months[13]. Although immune memory is what leads to long-term immunity, it is hard to predict how long immunity will last because the exact mechanisms of protective immunity used by our bodies against SARS-CoV-2 or COVID-19 are not yet known. The companies behind both Pfizer-BioNTech and Moderna, which are highly effective vaccines against existing variants including the Delta variant, explored whether or not their vaccines require boosters or genetic modifications to respond to emerging SARS-CoV-2 variants. The evolution of the virus has been so rapid that the Delta variant, which dominated the world at the time of writing, is at least twice as transmissible as the ancestral virus that was circulating.

Herd immunity (community immunity or population immunity) is explained as a population in a country that has a large number of people who are immune (one to two doses and/or booster dose are being analyzed) to the coronavirus[14]. Herd immunity can arise from infection or from getting vaccinated against COVID-19, but that does not necessarily mean that everyone has to be vaccinated. Rather, it means that the level of immunity in a population is large enough to prevent the coronavirus from spreading as easily as it once did. It also helps to protect groups at risk of contracting COVID-19 in the future according to medical principles. If people are vaccinated against COVID-19, their body naturally develops immunity to this virus. The research results suggest that the number of people who need to

have a certain level of immunity in the body to keep the whole country safe from the epidemic must be at the level of 70% of the population at the beginning[15]. However, it must not be forgotten that the virus is not dormant and it can change, evolve, and mutate over time according to the microbe's nature to survive. Herd immunity may not be successful in preventing the spread of a new or mutated coronavirus. However, immune individuals are unlikely to contribute to disease transmission, thus disrupting chains of infection, which stops or slows the spread of disease. The greater the proportion of immune individuals in a community, the smaller the probability that non-immune individuals will come into contact with an infectious individual[16-18].

On August 8, 2021, Prof. Dr. Yong Poovorawan, Head of the Center of Excellence in Clinical Virology at the Faculty of Medicine, Chulalongkorn University, pointed out that the percentage of the population of Thailand that must be vaccinated against Covid-19 increased to 85% from 70%, in order to build immunity among groups. This is necessary for the control of the epidemic, especially within children, whose immune systems need to be stimulated. When it comes to the Delta variant, which is assumed to be 1.5-2 times more infectious, he calculated that one patient can spread the disease to seven others, thereby making it easier to see the disease spread. The desired group immunity then changed to 85% of the population. The target group immunity will be achieved, so the next generation of vaccines will have to be developed to match the pandemic strains all the time[19].

The experts say that there are no fixed numbers for the proportion of the population that needs immunity. In fact, all of this depends on the factors within each country or region of the world, which is already different. As the virus mutates, there will be a need for another type of vaccination. In addition, more vaccine shots must be distributed to the people, and distributed faster. This is considered to be necessary, to catch up before the mutated virus can spread to more people in the area. That means the COVID-19 pandemic will not end all at the same time, because of the different vaccination levels around the world[20].

Usa Lek-Uthai, Dr.P.H.
Thai Editorial Board Member, Thai Journal of Public Health, Faculty of Public Health, Mahidol University, and Assoc. Prof., Department of Parasitology and Entomology, Faculty of Public Health, Mahidol University, Thailand. Email: usa.lek@mahidol.ac.th

References

1. World Health Organization. Coronavirus disease (COVID-2019) situation reports. 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200710-covid-19-sitrep-172.pdf ?sfvrsn= 70724b90_2, accessed 22 July, 2021.
2. Centers for Disease Control and Prevention (CDC). Understanding how COVID-19 vaccines work. Updated 13 January, 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/how-they-work.html, accessed 3 August, 2021.
3. Division of Disease Control, Ministry of Public Health. COVID-19. Available from: https://ddc.moph.go.th/viralpneumonia/faq_more.php, accessed 23 June, 2021.

4. Wang P, Nair MS, Liu L, Iketani S, Luo Y, Guo Y, et al. Antibody resistance of SARS-CoV-2 variants B.1.351 and B.1.1.7. Nature 2021; 593: 130-5.
5. Zhou D, Dejnirattisai W, Supasa P, Liu C, Mentzer AJ, Ginn HM, et al. Evidence of escape of SARS-CoV-2 variant B.1.351 from natural and vaccine-induced sera. Cell 2021; 189: 2348-61.
6. Graham BS. Rapid COVID-19 vaccine development. Science 2020; 368: 945-6.
7. Lurie N, Saville M, Hatchett R, Halton J. Developing COVID-19 vaccines at pandemic speed. N Engl J Med 2020; 382: 1969-73.
8. Caddy S. Developing a vaccine for Covid-19. BMJ 2020; 369: m1790.
9. WHO. Draft landscape of COVID-19 candidate vaccines. 2020. Available from: https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines, accessed 22 July, 2021.
10. Zhu FC, Guan XH, Li YH, Huang JY, Jiang T, Hou LH, et al. Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: A randomised, double-blind, placebo-controlled, phase 2 trial. Lancet 2021; 396: 479-88.
11. Zhu FC, Li YH, Guan XH, Hou LH, Wang WJ, Li JX, et al. Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: A dose-escalation, open-label, non-randomized, first-in-human trial. Lancet 2020; 395: 1845-54.
12. ChulaCov19. 13 August, 2021, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. Available from: https://www.prachachat.net/general/news-737877, accessed 13 August, 2021.
13. Dan JM, Mateus J, Kati Y, Hastie KM, Yu ED, Ramirez SI, et al. Immunological memory to SARS-CoV-2 assessed for up to 8 months after infection. Science 2021; doi 10.1126/science.abf4063.
14. Margolis H. Speaking of Science: Can herd-immunity protect us from Covid-19? 11 July, 2020, Available from: https://elkodaily.com/lifestyles/speaking-of-science-can- herd-immunity-protect-us-from-covid-19/article_953ed236-6ada-500a-8bec-d1e3f4838b12.html, accessed 15 July, 2021.
15. When Thai people have herd immunity? Available from: https://www.thaipost.net/main/detail/95530, accessed 10 August, 2021.
16. Poland GA, Ovsyannikova IG, Kennedy RB. SARS-CoV-2 immunity: Review and applications to phase 3 vaccine candidates. Lancet 2020; 396(10262): 1595-606.
17. Randolph HE, Barreiro LB. Herd immunity: Understanding COVID-19. Immunity 2020; 52(5): 737-41.
18. From genetics to herd immunity. Available from: https://www.weforum.org/agenda/2020/05/covid-19-top-science-stories-of-the-week-from-genetics-to-herd-immunity, accessed 23 July, 2021.
19. Herd Immunity update 85% vaccinated. Available from: https://www.thairath.co.th/news/local/2161166, accessed 8 August, 2021.
20. World Health Organization. Advice on the use of point-of-care immunodiagnostic tests for COVID-19. Available from: https://www.who.int/news-room/commentaries/detail/advice-on-the-use-of-point- of-care-immunodiagnostic-tests-for-covid-19, accessed 23 July, 2021.