Pacific International Journal, Vol. 6(1), 149-152; 2023
ISSN (Print) 2663-8991, ISSN (Online) 2616-48251
DOI: 10.55014/pij.v6i1.362
https://rclss.com/index.php/pij

COVID-19 Vaccine Boosters: Rationale, Efficacy, and Implementation Strategies

Purevbat Bazarjav[1], Ankhbayar Sandagdorj[1], Enkhbold Sereejav[2], Oyunsuren Enebish[2], Batbayar Ochirbat[1], Bilegtsaikhan Tsolmon[1,3], Tsogzolmaa Ganbold[1]

[1]The National Center for Diseases, Ulaanbaatar, Mongolia
[2]Ministry of Health, Ulaanbaatar, Mongolia
[3]Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia

E-mail: purevbatbazarjav@gmail.com; ankhbayarsnicmng@gmail.com; Bilegtsaikhan@gmail.com

***Corresponding Authors:** Bilegtsaikhan Tsolmon, National Center for Communicable Diseases of Mongolia, Nam Yan Ju Street, Ulaanbaatar 210648, Mongolia.

Abstract: The development of COVID-19 vaccines has been a major milestone in controlling the pandemic. However, with the emergence of SARS-CoV-2 variants and the potential for waning immunity, vaccine booster doses have become an essential consideration for maintaining vaccine effectiveness. In this review, we discuss the rationale for COVID-19 vaccine boosters, evidence of their efficacy, and implementation strategies. We also explore the challenges of global booster dose distribution and potential future research directions.

Keywords: COVID-19, vaccines, efficacy.

Introduction

The rapid development and deployment of COVID-19 vaccines have played a crucial role in controlling the pandemic and reducing the burden of disease. Multiple vaccines, including mRNA, viral vector, inactivated virus, and protein subunit vaccines, have demonstrated high efficacy in preventing severe illness, hospitalization, and death from COVID-19[1-3]. However, the emergence of SARS-CoV-2 variants and the potential for waning immunity over time have raised concerns about the durability of vaccine-induced protection. As a result, COVID-19 vaccine booster doses have become a topic of significant interest among researchers, public health officials, and policymakers. Booster doses are intended to bolster immune responses in individuals who have already received a primary vaccination series, enhancing protection against the virus and its variants[4-6]. In this review, we discuss the rationale for COVID-19 vaccine boosters, including the evidence supporting their efficacy, and implementation strategies. We also explore the challenges associated with global booster dose distribution and potential future research directions.

Rationale for COVID-19 Vaccine Boosters

Several factors contribute to the need for COVID-19 vaccine booster doses, including waning immunity, variants of concern, heterologous boosting, and high-risk populations. Immunity following vaccination or natural infection may decrease over time, increasing the risk of breakthrough infections[7, 8]. Booster doses can help maintain or enhance immune responses, providing more durable protection. The emergence of SARS-CoV-2 variants with increased transmissibility, virulence, or the ability to partially evade vaccine-induced immunity has underscored the need for booster doses. Boosters can be formulated to target specific variants, enhancing protection against these strains. Some individuals may experience suboptimal immune responses to certain vaccine platforms[9]. Heterologous boosting, where a booster dose is from a different platform than the primary series, may enhance immune responses in these individuals[10]. Certain populations, such as older adults, immunocompromised individuals, and healthcare workers,

[Received 05 Jan 2022; Accepted 22 March 2023; Published (online) 31 March 2023]

may be at higher risk for severe outcomes or waning immunity[11]. Booster doses may provide additional protection for these vulnerable groups.

Efficacy of COVID-19 Vaccine Boosters

Emerging evidence supports the efficacy of COVID-19 vaccine boosters in enhancing immune responses and protection against the virus and its variants[12]. Studies of third doses of the Pfizer-BioNTech and Moderna vaccines have shown that boosters can significantly increase neutralizing antibody levels and enhance protection against SARS-CoV-2 variants, including the Delta and Omicron variants. AstraZeneca's COVID-19 vaccine has been shown to elicit robust immune responses when used as a booster following a primary series of other vaccine platforms, including mRNA and inactivated virus vaccines[6, 13]. Several studies have demonstrated the potential benefits of heterologous boosting, where a booster dose from a different vaccine platform is administered following a primary series. For example, a study in the United Kingdom found that individuals who received a primary series of the AstraZeneca vaccine followed by an mRNA vaccine booster had higher neutralizing antibody levels than those who received a homologous AstraZeneca booster. Similar results have been observed for other vaccine combinations. In Mongolia, over 80% of the population received the BBIBP-CorV vaccine as full vaccination against COVID-19, while around 80% of population received BNT162b2 as a boodter dose. Mongolia conducted the study to evaluate the safety and immunogenicity of heterologous prime-boost vaccination using the BNT162b2, ChAdOx1n-Cov-19, Gam-COVID-Vac, and BBIBP-CorV vaccine for the first dose and the Pfizer-BioNTech and BBIBP-CorV vaccine for the second dose. The results showed a significant increase in the immune response. Booster doses have been shown to improve immune responses and protection in high-risk populations, such as older adults, immunocompromised individuals, and healthcare workers[14, 15]. Studies have indicated that booster doses can increase neutralizing antibody levels and reduce the risk of breakthrough infections in these groups.

Implementation Strategies and Challenges

To ensure the successful implementation of COVID-19 vaccine booster programs, several strategies and challenges need to be considered:

Timing of booster doses: Determining the optimal timing for booster doses is crucial for maximizing vaccine effectiveness. Studies have suggested that a booster dose administered six months or more after the primary series may be the most effective at enhancing immune responses[16].

Vaccine prioritization: Prioritizing booster doses for high-risk populations, such as older adults, immunocompromised individuals, and healthcare workers, can help maximize the impact of limited vaccine supplies and reduce the risk of severe outcomes[17].

Global equity: Ensuring equitable access to first dose and booster doses is essential to controlling the pandemic and preventing the emergence of new variants. Initiatives such as COVAX play a critical role in supporting equitable vaccine distribution, but further efforts are needed to improve access to vaccination programs including booster doses in low- and middle-income countries[18].

Public acceptance: Addressing vaccine hesitancy and promoting public confidence in booster doses is important for achieving high vaccination coverage. Transparent communication about the rationale, safety, and efficacy of booster doses can help build trust and encourage uptake[19].

Monitoring and surveillance: Ongoing surveillance of SARS-CoV-2 variants and vaccine effectiveness is essential for informing booster dose strategies and adapting vaccines to emerging strains[20].

Future Research Directions

As the COVID-19 pandemic continues to evolve, future research efforts should focus on duration of booster-induced immunity, next-generation vaccines, alternative vaccine platforms and delivery methods, and strategies for improving global equity. Understanding the longevity of protection provided by booster doses and determining the need for additional boosters or updated vaccines. Developing new vaccines that provide broader and more durable protection against diverse SARS-CoV-2 strains, including potential pan-coronavirus vaccines. Exploring novel vaccine platforms and delivery methods that can be more easily adapted to emerging viral strains and improve accessibility and

affordability. Identifying and implementing strategies to improve global access to COVID-19 vaccines and booster doses, addressing supply chain bottlenecks, and supporting technology transfer and local production in low- and middle-income countries[21, 22].

Conclusion

COVID-19 vaccine booster doses have emerged as an essential tool in maintaining and enhancing vaccine-induced immunity against the virus and its variants. Emerging evidence supports the efficacy of booster doses in increasing neutralizing antibody levels, enhancing protection against variants of concern, and improving immune responses in high-risk populations[20]. Successful implementation of booster dose programs requires addressing challenges such as global equity, vaccine prioritization, and public acceptance. Continued research and international collaboration are critical to refining booster dose strategies, developing next-generation vaccines, and ensuring the long-term control of the COVID-19 pandemic[21]. As we learn from the experiences of the COVID-19 pandemic, it is crucial to invest in public health infrastructure, research, and global cooperation to build a more resilient and equitable global health system, better prepared for future infectious disease threats.

Reference

1. Yuen KS, Ye ZW, Fung SY et al. SARS-CoV-2 and COVID-19: The most important research questions. Cell Biosci 2020; 10: 40. DOI: 10.1186/s13578-020-00404-4
2. Li M, Wang H, Tian L et al. COVID-19 vaccine development: milestones, lessons and prospects. Signal Transduction and Targeted Therapy 2022; 7: 146. DOI: 10.1038/s41392-022-00996-y
3. Ankhbayar Sandagdorj NT, Bayasgalan Namuutsetseg, Sarangua Ganbold, Khishigmunkh Chimedregzen, Uuganchimeg Munkhbayar, Gantsooj Baatar, Khurelbaatar Chuluundorj, Darmaa Badarch, Purevbat Bazarjav, Enkhsaikhan Lkhagvasuren, Nyamdavaa Pagvajav, Oyunsuren Enebish, Erdembileg Tsevegmed, Enkhbold Sereejav, Bumdelger Batmunkh, Bilegtsaikhan Tsolmon, Tsogzolmaa Ganbold. Correlation of Clinical Findings with Innate Immunity Against SARS-CoV-2 and Nucleic Acid Expression of SARS-CoV-2 Among Patients in Mongolia. Infectious Diseases Diagnosis & Treatment 2023; 7. DOI: 10.29011/2577-1515.100210
4. Kochhar S, Salmon DA. Planning for COVID-19 vaccines safety surveillance. Vaccine 2020; 38: 6194-6198. DOI: 10.1016/j.vaccine.2020.07.013
5. Abufares HI, Oyoun Alsoud L, Alqudah MAY et al. COVID-19 Vaccines, Effectiveness, and Immune Responses. DOI: 10.3390/ijms232315415
6. Grewal R, Nguyen L, Buchan SA et al. Effectiveness of mRNA COVID-19 vaccine booster doses against Omicron severe outcomes. Nature Communications 2023; 14: 1273. DOI: 10.1038/s41467-023-36566-1
7. Townsend JP, Hassler HB, Sah P et al. The durability of natural infection and vaccine-induced immunity against future infection by SARS-CoV-2. Proceedings of the National Academy of Sciences 2022; 119: e2204336119. DOI: 10.1073/pnas.2204336119
8. Lipsitch M, Krammer F, Regev-Yochay G et al. SARS-CoV-2 breakthrough infections in vaccinated individuals: measurement, causes and impact. Nat Rev Immunol 2022; 22: 57-65. DOI: 10.1038/s41577-021-00662-4
9. Khandia R, Singhal S, Alqahtani T et al. Emergence of SARS-CoV-2 Omicron (B.1.1.529) variant, salient features, high global health concerns and strategies to counter it amid ongoing COVID-19 pandemic. Environ Res 2022; 209: 112816. DOI: 10.1016/j.envres.2022.112816
10. Sapkota B, Saud B, Shrestha R et al. Heterologous prime-boost strategies for COVID-19 vaccines. J Travel Med 2022; 29. DOI: 10.1093/jtm/taab191
11. Bajaj V, Gadi N, Spihlman AP et al. Aging, Immunity, and COVID-19: How Age Influences the Host Immune Response to Coronavirus Infections? Frontiers in Physiology 2021; 11.
12. Chen Y, Liu Q, Zhou L et al. Emerging SARS-CoV-2 variants: Why, how, and what's next? Cell Insight 2022; 1: 100029. DOI: https://doi.org/10.1016/j.cellin.2022.100029
13. Huang Z, Xu S, Liu J et al. Effectiveness of inactivated and Ad5-nCoV COVID-19 vaccines against SARS-CoV-2 Omicron BA. 2 variant infection, severe illness, and death. BMC Medicine 2022; 20: 400. DOI: 10.1186/s12916-022-02606-8

14. Barros-Martins J, Hammerschmidt SI, Cossmann A et al. Immune responses against SARS-CoV-2 variants after heterologous and homologous ChAdOx1 nCoV-19/BNT162b2 vaccination. Nature Medicine 2021; 27: 1525-1529. DOI: 10.1038/s41591-021-01449-9
15. Atmar RL, Lyke KE, Deming ME et al. Homologous and Heterologous Covid-19 Booster Vaccinations. New England Journal of Medicine 2022; 386: 1046-1057. DOI: 10.1056/NEJMoa2116414
16. Andrews N, Stowe J, Kirsebom F et al. Effectiveness of COVID-19 booster vaccines against COVID-19-related symptoms, hospitalization and death in England. Nature Medicine 2022; 28: 831-837. DOI: 10.1038/s41591-022-01699-1
17. Tartof SY, Slezak JM, Puzniak L et al. Analysis of mRNA COVID-19 Vaccine Uptake Among Immunocompromised Individuals in a Large US Health System. JAMA Network Open 2023; 6: e2251833-e2251833. DOI: 10.1001/jamanetworkopen.2022.51833
18. Ye Y, Zhang Q, Wei X et al. Equitable access to COVID-19 vaccines makes a life-saving difference to all countries. Nature Human Behaviour 2022; 6: 207-216. DOI: 10.1038/s41562-022-01289-8
19. Shah A, Coiado OC. COVID-19 vaccine and booster hesitation around the world: A literature review. Frontiers in Medicine 2023; 9.
20. Lau JJ, Cheng SMS, Leung K et al. Real-world COVID-19 vaccine effectiveness against the Omicron BA.2 variant in a SARS-CoV-2 infection-naive population. Nature Medicine 2023; 29: 348-357. DOI: 10.1038/s41591-023-02219-5
21. Geng EH, Reid MJA, Goosby E et al. COVID-19 and global equity for health: The good, the bad, and the wicked. PLOS Medicine 2021; 18: e1003797. DOI: 10.1371/journal.pmed.1003797
22. Cao L, Lou J, Chan SY et al. Rapid evaluation of COVID-19 vaccine effectiveness against symptomatic infection with SARS-CoV-2 variants by analysis of genetic distance. Nature Medicine 2022; 28: 1715-1722. DOI: 10.1038/s41591-022-01877-1