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Letters to Editor

Recent developments in vaccine research: Novel platforms and applications in global health

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The ongoing global health challenges, underscored by the COVID-19 pandemic, have accelerated advancements in vaccine technology, highlighting the importance of novel vaccine platforms in addressing both emerging and endemic diseases [1]. This letter aims to review recent developments in vaccine platforms, particularly focusing on mRNA, viral vector, and protein subunit vaccines, and their potential applications in global health.

Traditional vaccine platforms, such as inactivated, live-attenuated, and subunit vaccines, have been foundational in the control of infectious diseases. These vaccines, including those for polio, hepatitis B, and influenza, have significantly reduced disease burden globally [2,3]. However, the limitations of traditional approaches, such as long development timelines, high production costs, and the complexity of scaling up for global distribution, have spurred the exploration of novel vaccine technologies [4,5].

Among the most promising innovations are mRNA vaccines, which gained significant attention during the COVID-19 pandemic. mRNA vaccines, exemplified by the Pfizer-BioNTech and Moderna vaccines, offer several advantages, including rapid development timelines, flexibility in design, and scalability for mass production. These vaccines have shown robust efficacy in preventing COVID-19 and have paved the way for broader applications in other infectious diseases, such as Rabies and HIV [6,7]. However, challenges remain, including the need for stringent cold-chain storage and the potential for immune tolerance over time [8].

Viral vector vaccines, which use modified viruses to deliver genetic material encoding for an antigen, have also seen substantial advancements. The AstraZeneca and Janssen COVID-19 vaccines are prominent examples of this platform. Viral vector vaccines are advantageous in terms of inducing strong immune responses and relatively simple manufacturing processes. However, pre-existing immunity to the viral vector may reduce their efficacy in certain populations [9]. Despite this, ongoing research is exploring the use of alternative vectors, such as vesicular stomatitis virus, to overcome this limitation [10].

Protein subunit vaccines, such as the Novavax COVID-19 vaccine, are another critical development.

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These vaccines use fragments of the pathogen to stimulate immunity without introducing the risk of live infection. Subunit vaccines are particularly beneficial for immunocompromised individuals and offer a safer profile compared to live-attenuated vaccines [11]. Furthermore, recent innovations in virus-like particle (VLP) vaccines have shown promise, particularly in developing vaccines for HPV and hepatitis B, with ongoing research aiming to extend their use to other pathogens [12].

The implications of these novel platforms extend beyond COVID-19, with applications in addressing long-standing global health issues. mRNA vaccines are being explored for Zika virus, and viral vector vaccines are being tested for HIV and tuberculosis [7,13,14]. These innovations offer the potential for more rapid and cost-effective vaccine development, which is crucial for responding to emerging infectious threats, particularly in low-resource settings . Moreover, novel vaccine technologies may reduce the cost and complexity of vaccine distribution, facilitating greater global access to life-saving immunization.

Despite these advances, challenges remain in terms of vaccine acceptance, distribution logistics, and ensuring equitable access, particularly in low-income countries. Cold-chain requirements and infrastructure limitations pose significant barriers to global vaccine rollout. Additionally, public trust in vaccines remains a critical challenge in many regions [3,8]. Continued research and global collaboration will be essential to overcoming these barriers and ensuring the benefits of novel vaccine technologies reach populations in need.

In conclusion, recent developments in vaccine platforms, particularly mRNA, viral vector, and protein subunit vaccines, represent a significant leap forward in global health. These innovations offer the potential to address both existing and emerging infectious diseases more efficiently and equitably. Continued investment in vaccine research, infrastructure, and global collaboration is critical to ensuring the widespread success of these novel platforms.

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Authors' contributions

SSA: conceived the review topic, defined the scope, and supervised the overall project. SSA, MM: performed the comprehensive literature search, data extraction, and organized the thematic structure of the manuscript. NB: contributed to data interpretation, synthesized the key findings, and drafted the initial version of the manuscript. All authors critically revised the manuscript for important intellectual content and approved the final version for submission.

Conflict of interest

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