OPEN ACCESS Freely available online

ISSN: 2576-389X
Journal of Infectious Diseases and Diagnosis

Perspective

Pertussis Vaccination Strategies: Addressing Waning Immunity and Pathogen Adaptation

Edward Hook*

Department of Medicine, Durham University, Durham, United Kingdom

DESCRIPTION

Pertussis, commonly known as whooping cough, is a highly contagious respiratory infection caused by *Bordetella pertussis*. Despite the availability of vaccines for more than half a century, pertussis remains a public health concern in many parts of the world. The disease is particularly dangerous for infants and young children, who face the highest risk of severe illness and complications. Vaccination has significantly reduced the global burden of pertussis, but questions regarding long-term immunity, vaccine types and the resurgence of cases continue to influence research and immunization policies.

History and types of pertussis vaccines

The earliest pertussis vaccines were developed in the 1940s as whole-cell vaccines. These contained inactivated *Bordetella pertussis* organisms and proved highly effective in reducing disease incidence. However, whole-cell vaccines were also associated with adverse reactions such as fever, swelling and local irritation, which raised safety concerns in the 1970s and 1980s.

To address these concerns, acellular pertussis vaccines were developed and introduced in the 1990s. Acellular vaccines are composed of purified antigens such as pertussis toxin, filamentous hemagglutinin, pertactin and fimbrial proteins. Compared with whole-cell vaccines, acellular formulations are associated with fewer side effects while still inducing protective immunity. However, studies have shown that immunity induced by acellular vaccines may wane more rapidly than that from whole-cell vaccines, leading to increased susceptibility over time.

Currently, pertussis vaccines are administered as combination formulations, such as DTP (Diphtheria, Tetanus, Pertussis) often provided in routine childhood immunization schedules. Booster doses are recommended for adolescents, adults and pregnant women to maintain immunity and protect newborns.

Global impact of pertussis vaccination

The introduction of pertussis vaccines dramatically reduced the prevalence and mortality associated with the disease. Before vaccination programs, pertussis was one of the leading causes of childhood mortality worldwide. The widespread use of whole-cell vaccines in the mid-20th century contributed to a sharp decline in incidence.

The transition to acellular vaccines in high-income countries during the 1990s maintained disease control, but an increase in reported cases has been observed in the last two decades. This resurgence has raised questions about waning immunity, pathogen adaptation and gaps in vaccination coverage. Nevertheless, vaccination remains the most effective means of controlling pertussis transmission and reducing disease severity.

Mechanisms of protection

Both whole-cell and acellular pertussis vaccines function by stimulating the immune system to recognize *Bordetella pertussis* antigens and generate protective antibodies. Whole-cell vaccines trigger a broad immune response involving both cellular and humoral immunity. In contrast, acellular vaccines tend to induce stronger antibody-mediated responses but less cellular immunity, which may explain the shorter duration of protection.

Maternal immunization has emerged as an important strategy for protecting newborns, who are too young to be vaccinated. Vaccinating pregnant women induces maternal antibodies that are transferred across the placenta, providing infants with passive protection during the first months of life.

Challenges and limitations

Despite high coverage rates in many countries, pertussis continues to circulate. Several challenges contribute to this situation. First, waning immunity following acellular vaccination

Correspondence to: Edward Hook, Department of Medicine, Durham University, Durham, United Kingdom, E-mail: edward@durham.edu.uk

Received: 30-Jun-2025, Manuscript No. JIDD-25-29511; **Editor assigned:** 03-Jul-2025, PreQC No. JIDD-25-29511 (PQ); **Reviewed:** 17-Jul-2025, QC No. JIDD-25-29511; **Revised:** 24-Jul-2025, Manuscript No. JIDD-25-29511 (R); **Published:** 31-Jul-2025, DOI: 10.35248/2576-389X.25.10.344

Citation: Hook E (2025). Pertussis Vaccination Strategies: Addressing Waning Immunity and Pathogen Adaptation. J Infect Dis Diagn. 10:344.

means that individuals can become susceptible within a few years after their last dose. This leads to asymptomatic or mild infections in adolescents and adults, who may transmit the bacteria to infants.

Second, genetic changes in circulating strains of *Bordetella pertussis* have been reported, including the emergence of strains lacking pertactin, one of the components of acellular vaccines. These adaptations may reduce the effectiveness of vaccines targeting specific antigens.

Third, disparities in vaccine access and uptake continue to affect disease burden, especially in low-income regions where vaccine coverage is incomplete. In such settings, pertussis remains a cause of infant mortality, highlighting the need for sustained immunization efforts.

Future directions

Ongoing research is exploring strategies to improve pertussis vaccines. These include the development of new acellular formulations that stimulate broader immune responses, the design of live attenuated vaccines and novel adjuvants to enhance durability of protection. Genetic and molecular studies of *Bordetella pertussis* are also providing insights into pathogen adaptation, which may guide the development of next-generation vaccines.

In addition, improved diagnostic methods and surveillance systems are being implemented to better track pertussis incidence and vaccine performance. By identifying outbreaks early, public health authorities can strengthen booster campaigns and maternal immunization programs.

CONCLUSION

Pertussis vaccines have transformed the global landscape of infectious disease prevention, significantly reducing mortality and morbidity associated with whooping cough. The transition from whole-cell to acellular vaccines improved safety profiles but introduced challenges related to waning immunity and pathogen adaptation. Continued research and innovation are needed to address these limitations and enhance long-term protection. Strengthening maternal immunization, ensuring equitable access to vaccines and developing improved formulations represent key strategies for controlling pertussis worldwide. Vaccination remains central to protecting vulnerable populations, particularly infants and reducing the burden of this enduring respiratory disease.