



An Over-View on Live-Attenuated Vaccines

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ABOUT THE STUDY

Live attenuated vaccines are made by weakening infectious organisms so that they can still replicate and induce protective immune responses in the host without causing disease. Vaccination with a live but attenuated organism induces an immune response that protects the vaccinated individual from serious disease or infection.

- Naturally occurring related organisms that are avirulent in humans, including host range restricted organisms or naturally occurring avirulent strains.
- Multiple rounds of growth of virulent organisms under conditions that weaken the organism such as in tissue culture or harsh physical conditions.
- Genetic manipulation of the organism to reduce virulence.

One of the first successful vaccination methods was live attenuated vaccines. The British doctor Edward Jenner used cowpox virus to immunise children against the deadly disease smallpox in the 18th century. This vaccination strategy was based on the observation that milkmaids, who were frequently exposed to cowpox at work, rarely contracted smallpox. Cowpox was eventually supplanted by the related vaccinia virus. Although the vaccinia and cowpox viruses are closely related to the smallpox virus, they cause minimal or mild disease in humans and have a high level of cross protection against smallpox. Smallpox was successfully eradicated in the late 1970s using a vaccinia virus-based vaccine.

Vaccines work by stimulating the production of pathogen-specific cells, such as CD8⁺ and CD4⁺ T lymphocytes, or molecules, such as antibodies. By killing infected cells or producing interleukins, the cells and molecules can either prevent or reduce infection. Depending on the vaccine, the specific effectors elicited may differ. The production of CD8⁺ cytotoxic T lymphocytes and T-dependent antibody responses is aided by live attenuated vaccines. A vaccine is only effective if

the body maintains a population of these cells. Without the need for multiple vaccine doses, live attenuated vaccines can induce long-term, possibly lifelong immunity. Cellular immune responses can also be induced by live attenuated vaccines.

Advantages

- Accurately imitate natural infections.
- Are effective at evoking both strong antibody and cell-mediated immune reactions.
- Can elicit long-lasting or life-long immunity.
- Often only one or two doses are required.
- Quick immunity onset.
- Cost-effective (compared to some other health interventions).
- Can have strong beneficial non-specific effects.

Disadvantages

- In rare cases, particularly when there is inadequate vaccination of the population, natural mutations during viral replication, or interference by related viruses, can cause an attenuated virus to revert to its wild-type form or mutate to a new strain, potentially resulting in the new virus being infectious or pathogenic.
- Often not recommended for immunodeficiency patients due to the risk of potentially severe complications.
- Live strains typically require advanced maintenance, such as refrigeration and fresh media, making transport to remote areas difficult and costly.

Live-attenuated vaccines generate a powerful and long-lasting immune response. Pathogens that have been attenuated are extremely unlikely to revert to their pathogenic form and cause disease. Furthermore, severe adverse reactions to the five WHO-recommended live attenuated vaccines (tuberculosis, oral polio, measles, rotavirus, and yellow fever) are extremely rare. However, no vaccine, like any medication or procedure, can be guaranteed to be completely safe or effective.

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