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Perspective

Immune Mechanism Induced by Live Attenuated Vaccine

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DESCRIPTION

To acquire immunity against pathogens in a safe manner, live vaccines use attenuated microbes. Because Live Attenuated Vaccines (LAVs) retain infectivity, vaccination stimulates a variety of immune responses by simulating natural infection. Specific protection is provided by the induction of pathogen-specific antibodies or cell-mediated cytotoxicity, but LAV can also elicit unintended off-target effects, known as non-specific effects. LAVs develop resistance to subsequent microbial infections through mechanisms such as short-lived genetic interference and non-specific innate immune response, as well as long-lasting trained immunity and heterologous immunity. LAVs may be considered as an alternative for immediate mitigation and control of unexpected pandemic outbreaks before pathogen-specific therapeutic and prophylactic measures are deployed due to their safety and potential for interference. Live-attenuated vaccines differ from traditional inactivated vaccines in that the pathogen (typically a virus) remains active in live vaccines, but is attenuated or modified in such a way that the pathogen cannot cause disease but can elicit a strong immune response. In general, live vaccines produce a stronger, longer-lasting, and more robust immune response than inactivated vaccines. These vaccines generate a strong and long-lasting immune response because they are so similar to the natural infection that they help prevent. Most live vaccines require only one or two doses to provide lifetime protection against a germ and the disease it causes.

However, because these live viruses have been attenuated, they are unable to replicate as effectively as live attenuated viruses. This means that they can no longer infect the host sufficiently, but can do so sufficiently for the host to develop broad and robust immunity. The immunological mechanism of live-attenuated vaccines typically involves a broad immune response that includes $CD4^+$ and $CD8^+$ T lymphocytes (T-cells) as well as antibodies against the pathogen (produced by B-cells). Live-attenuated vaccines typically provide long-term (potentially life-long) immunity without the need for additional doses in adulthood.

Live-attenuated vaccines have several advantages over other types of vaccines (such as inactivated), including the production of a robust, strong antibody and cell-mediated immune response, long-lasting immunity, and a relatively quick onset of action. Every year, influenza causes seasonal epidemics all over the world (see influenza). To combat influenza, a variety of vaccines, including inactivated and live-attenuated vaccines, are available. The LAIV can protect up to 90% of adults under the age of 65 and up to 40% of adults over the age of 65. LAIVs are typically administered through the nose, mimicking the influenza virus's natural infection route. Live-attenuated vaccines, like inactivated vaccines, must be carefully prepared, stored, transported, and administered. These are normally required to be kept at cold temperatures continuously, which may present a challenge in more remote areas of the world or where such facilities do not exist. Live-attenuated vaccines are highly effective and safe vaccines that are used to prevent a variety of viral diseases (such as influenza, measles, mumps, rubella, and chickenpox) as well as some bacterial diseases (such as cholera and TB). The pathogen remains viable in these vaccines, but it has been altered so that it can elicit an immune response but not cause infection. In general, these vaccines elicit stronger and broader immune responses than inactivated (killed pathogen) vaccines.

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