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Current Concepts of commonly used Vaccines

Ravikant[1] , Satish Gupte[1*] , Manju Bala[1], Tanveer kaur[1], Mandeep Kaur[1]
[1] Department of Microbiology, Gian Sagar Medical College & Hospital, Rajpura, India.

*Corresponding author :
Dr. Satish Gupte
Prof.& Head, Department of Microbiology, GianSagar Medical College and Hospital, Banur, Punjab
e.mail: drsatishgupte@hotmail.com

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Abstract

Today's world need vaccines for the prevention of infectious diseases, cancer therapy, and many more. Vaccines reduce the mortality rates in the world from infectious diseases such as measles, polio and diphtheria. The concept of vaccination is very old. Conventional vaccines are composed of Live or Attenuated microorganisms. But they may not be sufficient in current scenario, so further research is going on for development of vaccine which should be cost-effective and having specific immune responses. The current concept of vaccines is a challenge which could produce both humoral and cell-mediated immunity. In this review we are discussing about the types, concept, economics, and newer trends for vaccines production.
Keywords: Vaccines, types, concept, trends

Introduction

A vaccine is a biological preparation that provides active acquired immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins (1).

Vaccines can be prophylactic to prevent or ameliorate the effects of a future infection by any natural or "wild" pathogen, or therapeutic against cancer.

The terms vaccine and vaccination are derived from Variolae vaccinae (smallpox of the cow), the term devised by Edward Jenner to denote cowpox. To honour Jenner, Louis Pasteur proposed that the terms should be extended to cover the new protective inoculations then being developed. (2)

Types

There are several types of vaccines in use.(3) These represent different strategies used to try to reduce risk of illness, while retaining the ability to induce a beneficial immune response.

Inactivated:

Some vaccines contain inactivated, but previously virulent, micro-organisms that have been destroyed with chemicals, heat, radioactivity, or antibiotics. Examples are influenza, cholera, bubonic plague, polio, hepatitis A, and rabies.

Attenuated:

Some vaccines contain live, attenuated microorganisms. Many of these are active viruses that have been cultivated under conditions that disable their virulent properties, or that use closely related but less dangerous organisms to produce a broad immune response. Although most attenuated vaccines are viral, some are bacterial in nature. Examples include the viral diseases yellow fever, measles, rubella, and mumps, and the bacterial disease typhoid. The live Mycobacterium tuberculosis vaccine developed by Calmette and Guérin is not made of a contagious strain, but contains a virulently modified strain called "BCG" used to elicit an immune response to the vaccine. The live attenuated vaccine-containing strain Yersinia pestis EV is used for

plague immunization. Attenuated vaccines have some advantages and disadvantages. They typically provoke more durable immunological responses and are the preferred type for healthy adults. But they may not be safe for use in immunocompromised individuals, and may rarely mutate to a virulent form and cause disease.

Toxoid:

Toxoid vaccines are made from inactivated toxic compounds that cause illness rather than the micro-organism. Examples of toxoid-based vaccines include tetanus and diphtheria. Toxoid vaccines are known for their efficacy. Not all toxoids are for micro-organisms; for example, Crotalus atrox toxoid is used to vaccinate dogs against rattlesnake bites.

Subunit

Protein subunit – rather than introducing an inactivated or attenuated micro-organism to an immune system (which would constitute a "whole-agent" vaccine), a fragment of it can create an immune response. Examples include the subunit vaccine against Hepatitis B virus that is composed of only the surface proteins of the virus (previously extracted from the blood serum of chronically infected patients, but now produced by recombination of the viral genes into yeast), the virus-like particle (VLP) vaccine against human papillomavirus (HPV) that is composed of the viral major capsid protein, and the hemagglutinin and neuraminidase subunits of the influenza virus. Subunit vaccine is being used for plague immunization.

Conjugate

Certain bacteria have polysaccharide outer coats that are poorly immunogenic. By linking these outer coats to proteins (e.g., toxins), the immune system can be led to recognize the polysaccharide as if it were a protein antigen. This approach is used in the Haemophilus influenzae type B vaccine.

Experimental

A number of innovative vaccines are also in development and in use:

Dendritic cell vaccines combine dendritic cells with antigens in order to present the antigens to the body's white blood cells, thus stimulating an immune reaction. These vaccines have shown some positive preliminary results for treating brain tumors. (4)

Recombinant Vector – by combining the physiology of one micro-organism and the DNA of the other, immunity can be created against diseases that have complex infection processes
DNA vaccination – an alternative, experimental approach to vaccination called DNA vaccination, created from an infectious agent's DNA, is under development. The proposed mechanism is the insertion (and expression, enhanced by the use of electroporation, triggering immune system recognition) of viral or bacterial DNA into human or animal cells. Some cells of the immune system that recognize the proteins expressed will mount an attack against these proteins and cells expressing them. Because these cells live for a very long time, if the pathogen that normally expresses these proteins is encountered at a later time, they will be attacked instantly by the immune system. One potential advantage of DNA vaccines is that they are very easy to produce and store. As of 2015, DNA vaccination is still experimental and is not approved for human use.

T-cell receptor peptide vaccines are under development for several diseases using models of Valley Fever, stomatitis, and atopic dermatitis. These peptides have been shown to modulate cytokine production and improve cell mediated immunity. Targeting of identified bacterial proteins that are involved in complement inhibition would neutralize the key bacterial virulence mechanism. (5) While most vaccines are created using inactivated or attenuated compounds from micro-organisms, synthetic vaccines are composed mainly or wholly of synthetic peptides, carbohydrates, or antigens.

Valence

Vaccines may be monovalent (also called univalent) or multivalent (also called polyvalent). A monovalent vaccine is designed to immunize against a single antigen or single microorganism. A multivalent or polyvalent vaccine is designed to immunize against two or

more strains of the same microorganism, or against two or more microorganisms. The valency of a multivalent vaccine may be denoted with a Greek or Latin prefix (e.g., tetravalent or quadrivalent). In certain cases a monovalent vaccine may be preferable for rapidly developing a strong immune response.

Heterotypic

Also known as Heterologous or "Jennerian" vaccines these are vaccines that are pathogens of other animals that either do not cause disease or cause mild disease in the organism being treated. The classic example is Jenner's use of cowpox to protect against smallpox. A current example is the use of BCG vaccine made from Mycobacterium bovis to protect against human tuberculosis.

Economics of development

One challenge in vaccine development is economic: Many of the diseases most demanding a vaccine, including HIV, malaria and tuberculosis, exist principally in poor countries. Pharmaceutical firms and biotechnology companies have little incentive to develop vaccines for these diseases, because there is little revenue potential. Even in more affluent countries, financial returns are usually minimal and the financial and other risks are great.

Most vaccine development to date has relied on "push" funding by government, universities and non-profit organizations. Many vaccines have been highly cost effective and beneficial for public health. (6) The number of vaccines actually administered has risen dramatically in recent decades. This increase, particularly in the number of different vaccines administered to children before entry into schools may be due to government mandates and support, rather than economic incentive.

Role of preservatives

Many vaccines need preservatives to prevent serious adverse effects such as Staphylococcus infection, which in one 1928 incident killed 12 of 21 children inoculated with

adiphtheria vaccine that lacked a preservative.(7) Several preservatives are available, including thiomersal, phenoxyethanol, and formaldehyde. Thiomersal is more effective against bacteria, has a better shelf-life, and improves vaccine stability, potency, and safety; but, in the U.S., the European Union, and a few other affluent countries, it is no longer used as a preservative in childhood vaccines, as a precautionary measure due to its mercury content. Although controversial claims have been made that thiomersal contributes to autism, no convincing scientific evidence supports these claims.

Trends

Vaccine development has several trends (8) Until recently most vaccines were aimed at infants and children, but adolescents and adults are increasingly being targeted.Combinations of vaccines are becoming more common; vaccines containing five or more components are used in many parts of the world. In 2013, Biofarma has released a new product called Pentabio, which is combination vaccine of Diphtheria, Tetanus, Pertussis, Hepatitis B, and Haemophilus Influenzae Type B for baby/infant in Indonesia's Immunization Program.

New methods of administering vaccines are being developed such as skin patches, aerosols via inhalation devices, and eating genetically engineered plants. Vaccines are being designed to stimulate innate immune responses, as well as adaptive. Attempts are being made to develop vaccines to help cure chronic infections, as opposed to preventing disease. Vaccines are being developed to defend against bioterrorist attacks such as anthrax, plague, and smallpox. Appreciation for sex and pregnancy differences in vaccine responses "might change the strategies used by public health officials". Scientists are now trying to develop synthetic vaccines by reconstructing the outside structure of a virus. (9)

Principles that govern the immune response can now be used in tailor-made vaccines against many noninfectious human diseases, such as cancers and autoimmune disorders. For example, the

experimental vaccine CYT006-AngQb has been investigated as a possible treatment for high blood pressure. Factors that have impact on the trends of vaccine development include progress in translator medicine, demographics, regulatory science, political, cultural, and social responses.

Plants as bioreactors for vaccine production

Transgenic plants have been identified as promising expression systems for vaccine production. Complex plants such as tobacco, potato, tomato, and banana can have genes inserted that cause them to produce vaccines usable for humans.(10) Bananas have been developed that produce a human vaccine against hepatitis B.(11) Another example is the expression of a fusion protein in alfalfa transgenic plants for the selective directioning to antigen presenting cells, therefore increasing vaccine potency against Bovine Viral Diarrhea Virus (BVDV).

Vaccine for swine flu

For Influenza A (H1N1) 2009 Monovalent Vaccine –Injectable and Intranasal --Live, attenuated vaccine are available. Inactivated- Active immunization of persons ages 4 to 18 years of age and older against influenza disease caused by pandemic (H1N1) 2009 virus while live attenuated is given single-dose intranasal sprayer-- Active immunization of individuals 2-49 years of age against influenza disease caused by pandemic (H1N1) 2009 virus (12).

Vaccine for HIV

Preventive vaccine • contain only individual parts of HIV, rather than the whole virus. Instead of collecting thesparts from the virus itself, the HIV subunits are made in the laboratory using genetic engineering techniques. These man-made subunits alone—without the rest of the virus—can prompt the body to produce an anti-HIV immune response, although that response may be too weak to actually protect against future HIV infection. • Recombinant vector vaccines take advantage of non-HIV viruses that either don't cause disease in humans or have been deliberately weakened so that they can't cause disease. These weakened (attenuated) viruses are used as vectors, or carriers, to deliver copies of HIV genes into the cells of the body. Once inside cells, the body uses the

instructions carried in the copies of HIV genes to produce HIV proteins. As with subunit vaccines, these HIV proteins can stimulate an anti-HIV immune response. Most of the recombinant vector vaccines for HIV deliver several HIV genes (but not the complete set) and may therefore create a stronger immune response. Some of the virus vectors being studied for HIV vaccines include ALVAC (a canarypox virus), MVA (a type of cowpox virus), VEE (a virus that normally infects horses), and adenovirus-5 (a human virus that doesn't usually cause serious disease) based vectors. • DNA vaccines also introduce HIV genes into the body. Unlike recombinant vector vaccines, DNA vaccines do not rely on a virus vector. Instead, "naked" DNA containing HIV genes is injected directly into the body. Cells take up this DNA and use it to produce HIV proteins.

Therapeutic vaccine

A therapeutic HIV vaccine (also known as a treatment vaccine) is a vaccine used in the treatment of an HIV infected person. Therapeutic HIV vaccines are designed to boost the body's immune response to HIV in order to better control the infection. Currently, there are no therapeutic HIV vaccines approved by the Food and Drug Administration (FDA). However, therapeutic HIV vaccines are being tested in clinical trials to find out if they are safe and effective in treating people with HIV. Researchers hope that if therapeutic vaccines are able to strengthen the body's natural anti-HIV immune response, people with HIV will not have to rely exclusively on the antiretroviral drugs now used to treat HIV infection. Currently, antiretroviral drugs must be taken for life, and some cause serious side effects. All experimental therapeutic HIV vaccines are in very early stages of research, and no therapeutic vaccine is anticipated to be available to the general public for many years, if at all (13).

Vaccine for malaria

Current approaches are focusing on recombinant protein and attenuated whole organism vaccines. Various reached the state of clinical trials; most demonstrated insufficient immunogenicity. There is no practical or effective vaccine that has been introduced into clinical practice but the latest on trail are.

RTS,S

RTS,S is the most recently developed recombinant vaccine. It consists of the P. falciparum circumsporozoite protein from the pre-erythrocytic stage. The CSP antigen causes the production of antibodies capable of preventing the invasion of hepatocytes and additionally elicits a cellular response enabling the destruction of infected hepatocytes. The CSP vaccine presented problems in trials due to its poor immunogenicity. The RTS,S attempted to avoid these by fusing the protein with a surface antigen from Hepatitis B, hence creating a more potent and immunogenic vaccine.

RTS,S/AS01 (commercial name: Mosquirix),was engineered using genes from the outer protein of Plasmodium falciparum malaria parasite and a portion of a hepatitis B virus plus a chemical adjuvant to boost the immune system response. Infection is prevented by inducing high antibody titers that block the parasite from infecting the liver.

PfSPZ Vaccine

SANARIA® PfSPZ vaccine is a preventative malaria vaccine which is made of non-replicating irradiated whole sporozoites developed by Sanaria Inc. PfSPZ is the acronym of words: Plasmodium falciparum (Pf) and sporozoites (SPZ). (14)

Vaccine for tuberculosis

Tuberculosis (TB) vaccines are vaccinations intended for the prevention of tuberculosis. Immunotherapy as a defence against TB was first proposed in 1890 by Robert Koch.Today, there is only one tuberculosis vaccine available, bacilli Calmetter-Guérin (BCG), which has been around since 1921. Only three out of every 10,000 people who get the vaccine experience side effects. (15) Although BCG immunization provides optimal protection for infants and young children, (including defence against TB meningitis and miliary TB), it poses unpredictable and inconsistent consequences in adults, with efficacy ranging from 0%-80%. Several confounding variables are considered responsible for varying outcomes. Demand for TB immunotherapy

advancement exists because the disease has become increasingly drug-resistant. (16).Other tuberculosis vaccines in development are: MVA85A, rBCG30, 72F fusion protein, ESAT6-Ag85b fusion protein

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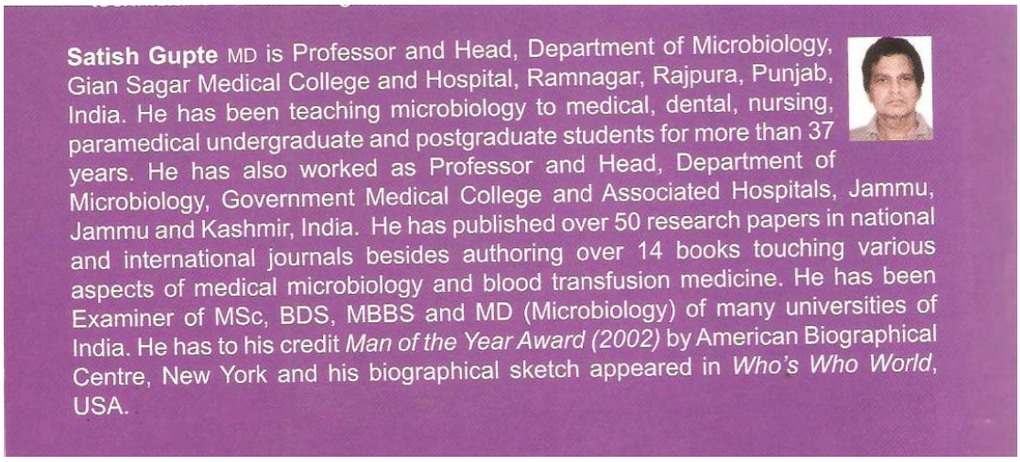
Authors Column



Satish Gupte MD is Professor and Head, Department of Microbiology, Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Punjab, India. He has been teaching microbiology to medical, dental, nursing, paramedical undergraduate and postgraduate students for more than 37 years. He has also worked as Professor and Head, Department of Microbiology, Government Medical College and Associated Hospitals, Jammu, Jammu and Kashmir, India. He has published over 50 research papers in national and international journals besides authoring over 14 books touching various aspects of medical microbiology and blood transfusion medicine. He has been Examiner of MSc, BDS, MBBS and MD (Microbiology) of many universities of India. He has to his credit *Man of the Year Award (2002)* by American Biographical Centre, New York and his biographical sketch appeared in *Who's Who World*, USA.

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