Concepts of Immunity and Recent Immunization Programme against COVID-19 in India

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Abstract

To safely achieve herd immunity against COVID-19, a substantial proportion of a population would need to be vaccinated, lowering the overall amount of virus able to spread in the whole population. India has leveraged its manufacturing capacity to pre-order 600 million doses of potential COVID-19 vaccine and negotiating for another billion doses, says a new global analysis of advance market commitments (AMC) for vaccine candidates against the corona virus. India is planning to start the distribution of COVID-19 vaccine first to the healthcare workers followed by other groups to be added sequentially as there are five COVID-19 vaccines under trials in India such as COVAXIN, Covishield, 2yCoV-D, Sputinik and Biological E's novel Covid-19 vaccine. Out of these five, COVAXIN and Covishield are approved by DCGI (Drugs Controller General of India) for restricted use in emergency situation.

Introduction

The function of the immune system is to protect the body from invasion. Immune cells recognize and remove foreign invaders mainly microorganisms, viruses, proteins and carbohydrates derived from these organisms. The term ‘immunity’ is defined as resistance exhibited by the host against any antigens (microorganisms, viruses, proteins and carbohydrates derived from these organisms). This resistance plays a major role in prevention of infectious diseases. Immunity may be innate immunity or acquired immunity. Immunogenicity and antigenicity are related but distinct immunologic properties that sometimes are confused. Immunogenicity is the ability to induce a humoral and/ or cell mediated immune response: Although a substance that induces a specific immune response is usually called an antigen, it is more appropriately called an immunogen. Antigenicity is the ability to combine specifically with the final products of the above responses (i.e., antibodies and/ or cell-surface receptors). Although all molecules that have the property of immunogenicity also have the property of antigenicity, the reverse is not true. Some small molecules, called haptens, are antigenic but incapable, by themselves, of inducing a specific immune response.

Innate Immunity

Innate immunity can be seen to comprise four types of defensive barriers: anatomic, physiologic, phagocytic, and inflammatory Skin not only acts as a Anatomic barrier to microorganisms. The inhaled particles are arrested in the nasal passages on the moist mucous membrane surfaces. The mucous secretions of respiratory tract act as a trapping mechanism and hair like cilia propels the particles towards the pharynx where it is swallowed or coughed out. The
cough reflex acts as an important defense mechanism. The mouth possesses saliva which has an inhibitory effect on many microorganisms. Some bacteria may be swallowed and are destroyed by the acidic pH of gastric juice. Normal body temperature inhibits growth of some pathogens. Fever response inhibits growth of some pathogens. Acidity of stomach contents (i.e. low pH) kills most ingested microorganisms. Interferon induces antiviral state in uninfected cells. Complement lysed microorganisms or facilitates phagocytosis. Various cells internalize (endocytose) and break down foreign macromolecules. Specialized cells (blood monocytes, neutrophils, tissue macrophages) internalize (phagocytose), kill, and digest whole microorganisms. Tissue damage and infection induce leakage of vascular fluid, containing serum proteins with antibacterial activity, and influx of phagocytic cells into the affected area.

**Acquired Immunity**

The resistance acquired by an individual during life is known as acquired immunity. Acquired immunity is capable of recognizing and selectively eliminating specific foreign microorganisms and molecules (i.e., foreign antigens). Active acquired immunity is of two types: Natural active immunity or artificial active immunity. Natural active immunity is acquired by natural exposure of an individual to the infectious agents. Such immunity is long lasting. Persons recovering from smallpox infection develop natural active immunity. Artificial active immunity is produced by immunization or vaccination. The vaccines are prepared from live, attenuated or killed microorganisms, or their antigens or toxoids.

**Immune Response**

The specific reactivity induced in a host following an antigen stimulus is known as the immune response. It is of two types: Humoral or antibody mediated immunity, Cell-mediated immunity. In humoral immunity B-cell undergoes proliferation and differentiates into plasma cells that synthesizes and secretes antibodies. B-cell carries receptors which consist of IgM or other immunoglobulin classes. However in primary hormonal response plasma cell initially secretes IgM and later switching over to form IgG. Following antigenic stimulus, not all B-lymphocytes get converted into plasma cells. A small proportion of them develop into ‘memory cells’ which have long life span and can recognize the same antigen on subsequent exposure. The increased antibody response during secondary antigenic stimulus is due to the memory cells induced by the primary contact with the antigen. In Cell-mediated immunity the peptides displayed by both types of MHC proteins are inspected by T-cells, which have antigen receptors on their plasmalemma. T-cell antigen receptors recognise the combined peptide + MHC complex and are therefore specific for either Class I or Class II MHC proteins.

These T-lymphocytes can be subdivided into “helper” Th cells and “cytotoxic” Tc cells). Helper T-lymphocytes normally bear a CD4 surface protein. They recognize peptides bound to Class II MHC molecules, usually on myeloid APCs, but they also recognize peptides displayed by B-cells. This cell-mediated immunity eliminates some tumours and many virus-infected cells, before the virus can infect other cells.

**Herd Immunity**

Herd immunity, also known as ‘population immunity’, is the indirect protection from an infectious disease that happens when a population is immune either through vaccination or immunity developed through previous infection. WHO supports achieving ‘herd immunity’ through vaccination, not by allowing a disease to spread through any segment of the population, as this would result in unnecessary cases and deaths. Herd immunity against COVID-19 should be achieved by protecting people through vaccination, not by exposing them to the pathogen that causes the disease. Vaccines train our immune systems to create proteins that fight disease, known as ‘antibodies’, just as would happen when we are exposed to a disease but crucially vaccines work without making us sick. Vaccinated people are protected from getting the disease in question and passing on the pathogen, breaking any chains of transmission.

**Vaccines and Immunization**

Immunization is a key component of primary health care and an indisputable human right. It’s also one of the best health investments money can buy. Vaccines are also critical to the prevention and control of infectious-disease outbreaks. They underpin global health security and will be a vital tool in the battle against antimicrobial resistance. Yet despite tremendous progress, far too many people around the world – including nearly 20 million infants each year – have insufficient access to vaccines. In some countries, progress has stalled or even reversed, and there is a real risk that complacency will undermine past achievements. The world is in the midst of a COVID-19 pandemic. As WHO and partners work together on the response tracking the pandemic, advising on critical interventions, distributing vital medical supplies to those in need, they are racing to develop and deploy safe and effective vaccines. Vaccines save millions of lives each year. Vaccines work by training and preparing the body’s natural defences, the immune system to recognize and fight off the viruses and bacteria they target. If the body is exposed to those disease-causing germs later, the body is immediately ready to destroy them, preventing illness. There are currently more than 50 COVID-19 vaccine candidates in trials. WHO is working in collaboration with scientists, business, and global health organizations through the ACT Accelerator to speed up the pandemic response. When a safe and effective vaccine is found, COVAX (led by WHO, GAVI and CEPI) will facilitate
the equitable access and distribution of these vaccines to protect people in all countries. People most at risk will be prioritized. While we work towards rolling out a safe and effective vaccine fairly, we must continue the essential public health actions to suppress transmission and reduce mortality.

### Worldwide COVID-19 Candidate Vaccines

In order to respond quickly and effectively to the COVID-19 pandemic, a broad range of candidate COVID-19 vaccines are being investigated globally using various technologies and platforms. These include viral-vectored, protein subunit, nucleic acid (DNA, RNA), live attenuated and inactivated vaccines. Some of these candidates have entered clinical trials.

![Figure 1: Number of vaccine candidates in clinical phase worldwide (www.who.int)](image1)

![Figure 2: Percentage of vaccine candidates in clinical phase worldwide (www.who.int)](image2)

### Covid-19 Vaccines under Trials in India

**COVAXIN**

COVAXINTM, India’s indigenous COVID-19 vaccine Bharat Biotech is developed in collaboration with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV). This indigenous, inactivated vaccine is developed and manufactured in Bharat Biotech’s BSL-3 (Bio-Safety Level 3) high containment facility. The vaccine received approval from Drug Controller General of India (DCGI) for Phase I & II Human Clinical Trials and an Adaptive, Seamless Phase I, Followed by Phase II Randomized, Double blind, Multicentre Study to Evaluate the Safety, Reactogenicity,

Tolerability and Immunogenicity of the Whole-Virion Inactivated SARS-CoV-2 Vaccine (BBV152). DCGI approved for restricted use in emergency situation.

**Covishield**

India’s drug regulator has given the green light to Covishield (the local name for the Oxford-AstraZeneca vaccine developed in the UK). The Serum Institute of India (SII) and Indian Council of Medical Research are jointly conducting a Phase II/III, Observer-Blind, Randomized, Controlled Study to Determine the Safety and Immunogenicity of Covishield (COVID-19 Vaccine). DCGI approved for restricted use in emergency situation.

**ZyCoV-D**

Zydus Cadila, focused on discovering and developing NCEs, Novel Biologicals, Biosimilars and Vaccines, announced that its plasmid DNA vaccine to prevent COVID-19, ZyCoV-D. Safety in Phase I clinical trial of ZyCoV-D in healthy subjects established as endorsed by the independent Data Safety Monitoring Board (DSMB). Zydus commenced Phase II trial. DCGI approved for Phase III Human Clinical Trials.

**Sputinik and Biological E’s Novel Covid-19 Vaccine**

Dr Reddys Laboratories Limited and Sputnik LLC are jointly conducting Multi-centre, phase II/III adaptive clinical trial to assess safety and immunogenicity of Gam-COVID-Vac combined vector vaccine. DCGI approved for Phase II & Phase III Human Clinical Trials and Phase II Human Clinical Trial is ongoing. Biological E. Limited is conducting a prospective open label randomised Phase-I seamlessly followed by Phase-II study to assess the safety, reactogenicity and immunogenicity of Biological E’s novel Covid-19 vaccine containing Receptor Binding Domain of SARS-CoV-2 for protection against Covid-19 disease when administered intramuscularly in a two dose schedule (0, 28D) to healthy volunteers. DCGI approved for Phase I & Phase II Human Clinical Trials and Phase I/II Human Clinical Trial is ongoing.

![Figure 3: Covid-19 vaccines under trials in India (www.icmr.org.in)](image3)
**Conclusion**

Two COVID-19 vaccines have been approved by the Drug Control General of India (DCGI)’s approval for restricted emergency use. Serum Institute of India and Bharat Biotech are ready to supply vaccines for the first phase of the vaccination which will include frontline workers followed by people who are above 50 years old. For further vaccination process, the central government has introduced an application named Co-WIN (Covid Vaccine Intelligence Work), which has been developed as a comprehensive cloud-based IT solution for planning, implementation & monitoring of COVID-19 vaccination in India. Co-WIN system on a real-time basis will track not only the beneficiaries but also the vaccines, at national, state and district level.

**References**
